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(54) Automation of the design recovery and forward engineering of legacy applications

(57) A method of recovering design information of a legacy application program 3A comprising translating the legacy application program into tokens representing elements of the program, and automatically rewriting the legacy application program using the tokens to define elements to be included in the rewritten program.

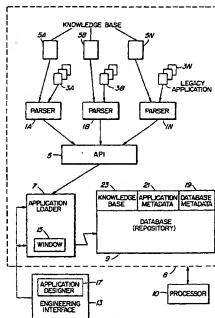


FIG. 1

Description

FIELD OF THE INVENTION

- 5 [0001] This invention relates to methods of operating computers, and in particular to a method of recovering design information of a legacy application program.

BACKGROUND TO THE INVENTION

- 10 [0002] As time passes, new computer program languages are created, and old ones fall out of favor. The number of programmers who are sufficiently knowledgeable to maintain an old program gradually decreases. Background documentation concerning the structure of such programs is lost. Indeed, many existing (legacy) programs have been in use for decades, with few, if any programmers left who can modify them, and with little or no documentation which can be used as a base from which modification can be made.
- 15 [0003] The above problems have become very clear with the onset of the "year 2000 problem", by which programs which had been written designating the year using the last two numerical digits instead of four will create errors with the turn of the century. These legacy programs must be modified to correct the year to four digits and to be able to handle four digits, but due to insufficient programmers who know these legacy programs, learning and correction of the programs is generally time consuming and therefore is costly.
- 20 [0004] In order to avoid the above problems, it is sometimes desirable to substitute a new program written in a more modern and widely used language. However, to do this, the business rules processed by the legacy program must be uncovered, and the program completely rewritten in the new language. Both the uncovering and rewriting processes are generally very time consuming and therefore costly.

25 SUMMARY OF THE INVENTION

- [0005] The present invention is a method of automating the recovery of design information of a legacy application program, and which can be used to provide a modified representative of the legacy application program in the previous language or to provide a new application program in a different computer language, or can be used for display of various
- 30 aspects of the design information of the legacy application. Since the process is automated both in the analysis and program creation, it takes considerably less time and cost than in the past.
- [0006] Further, documentation of the legacy application, modified legacy application or new application can be automated, thus making analysis of the application easier.
- [0007] In accordance with an embodiment of the present invention, a method of recovering design information of a
- 35 legacy application program comprises using a common set of tokens to represent corresponding elements of a plurality of different application programs which are in the same or in different languages, and using a set of the tokens relating to a particular legacy application program to display aspects of the legacy application program or to construct another application program in the same or in a different language which is similar to or is modified from the legacy application program.
- 40 [0008] In accordance with another embodiment, a method of recovering design information of a legacy application program is comprised of translating the legacy application program into tokens representing elements of the program, and automatically rewriting the legacy application program using the tokens to define elements to be included in the rewritten program.
- [0009] In accordance with another embodiment, a method of recovering design information of a legacy application
- 45 program comprises:
- (a) parsing an application program to obtain plural parsed program parts,
 - (b) storing plural tokens which are common to similar functioning program parts of various computer languages in a database,
 - 50 (c) mapping the parsed program parts to corresponding ones of the common tokens in the database, and storing the map in the database, and
 - (d) using the mapped tokens to generate a modified legacy application, a new application in a same language as the legacy application, a new application in a language different from the legacy application, or for display of aspects of the legacy or new application via a user interface.
- 55

BRIEF DESCRIPTION OF THE DRAWINGS

- [0010] A better understanding of the invention will be obtained by a consideration of the detailed description below,

in conjunction with the following drawings, in which:

Figure 1 is a block diagram of the preferred embodiment of the invention,

Figure 2 is a block diagram of a preferred embodiment of an engineering interface which is used in the embodiment of Figure 1,

Figure 3 is a representation of a portion of a data model,

Figure 4 is a representation of portions of the data model that represents navigator data structures in more detail, and

Figure 5 is a screenshot of a tree view for the preferred embodiment of the invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0011] A glossary of terms used in the description below follows:

15	ANSI	American National Standards Institute
	API	Application Programmatic Interface
	Application	A series of inter-related programs which, when used together, automate a solution for a business problem
	Application Metadata	Data which describes the objects and methods of an application
20	Borland Interbase	A Commercial Relational Database Management System owned by the company currently known as Borland
	COBOL	Common Business Oriented Language
	Data Model	A representation of the data structures and relationships between these data structures which describe a business application
25	Data Structure	One or more data elements in a particular data relationship usually used to describe some entity
	Grammar	A syntactical representation of a programming language
	Legacy Application Program	An older application (usually written in a third generation language which automates a business function or functions)
30	LEX	A commercially available software application which is used to tokenize strings in a human readable text file(s) (Lexical Analyzer)
	Metadata	Data which describes the structures in a database
	ODBC	Open Database Connectivity
	Oracle RDBMS	A Commercial Relational Database Management System owned by the company currently known as Oracle Corporation
35	Parser	A computer program which is used to break down the grammar of a particular computer programming language
	PL/SQL	A computer programming language known as Procedure Language Structures Query Language commercially owned by Oracle Corporation
40	PowerHouse	A fourth generation programming language owned by Cognos Corporation
	RDBMS	Relational Database Management System
	Relational Database	A data base constructed out of normalized data structures
	Repository	A relational database used to store the metadata and application metadata of a business computer application
45	Reverse Engineering	The process of decomposing the objects and methods which make up a computer program into a format easily understandable by a person
	SQL	Structures Query Language
	Symbol	A numeric representation of an entity
	Token	An individual object in a repository
50	Transaction	The logical grouping of objections on a database that can be performed or undone against a relational database
	Tree View	A user interface which operates on the same principals as Microsoft Explorer™ interface
	User Interface	A computer display operated by the user of an application to facilitate the usage of the application
55	Visual Basic	A computer language owned by Microsoft Corporation that is used to build Windows Based Applications
	YACC	Yet another Compiler Compiler. A program which aides in the development of computer parsers usually coupled with the grammar of a computer language.

[0012] Turning to Figure 1, a parser 1A is used to break out the various parts of a legacy application program 3A. Indeed, it is preferred that plural parsers 1A - 1N should be used in the invention, each one corresponding to a different program language, e.g. COBOL, PowerHouse, Interbase, ANSI SQL, etc. Thus programs 3A - 3N written in any source legacy language may be parsed by a corresponding parser.

[0013] Each parser scans the legacy application program, and accesses a corresponding knowledge base 5A - 5M specific to its language, which stores representations of every command and option available in the source program language, i.e. its "grammar", to enable it to parse a program having source code written in its language. The legacy code is thus decomposed into individual objects and their associated methods, based on the knowledge base.

[0014] The objects, methods and business rules generated by the parser are in the form of standard tokens for all parsers, which can be also considered intermediate files which are readable by the application interface API, and which has a "front end" 7 which interfaces a preferably relational database 9 (i.e. repository). The repository stores the standard tokens in a record or in a separate database for the particular legacy program which has been parsed. The parsed program parts are thus mapped to corresponding ones of plural common tokens in the repository.

[0015] While the above is a preferred way of mapping the program parts to corresponding common tokens, alternatively the parsers can generate files or words which, when applied to the database, are stored as pointers to specific standard tokens which have already been prestored.

[0016] It is an important aspect of the invention that common tokens are used for all legacy languages. These common tokens can then be looked up and used for reverse engineering of a legacy program, for documentation, for recreation of the legacy program with modification, and for creation of a new program in the same language as the legacy program or in a different language than the legacy program, to provide the same tasks the legacy application was developed to perform. All of the above programs can be stored in a memory 8 coupled to a processor of a server, for operating the method described herein.

[0017] An engineering interface 13 stored on another computer (or on the same server) is coupled to the database 9 via a user window 15 provided by the application front end 7. This allows a user to access the records specific to a program, to modify it, to obtain the stored data to provide to another application design program 17 (e.g. Oracle Designer/2000) to create a modified legacy application program or to create a new application program in a different language.

[0018] Thus under control of a user, the engineering interface accesses the desired legacy application program records from the database 9 via window 15, sends its tokens to forward engineering program 17 and commands it to translate the tokens to a new program in a different language. It can be instructed by the application designer to modify all of a particular parameter (such as a two digit date indicator token to four digits), while creating a new application program using the same design rules indicated by the common tokens used in the translated legacy application. The new application program can be in the legacy language, resulting in the automatic correction of the date in the legacy application program to avoid the "year 2000" problem described earlier. As the newly reconstituted program is being created, routines thereof are used by the engineering interface 13 for checking the recreated tokens against those designated in the stored database or record relating to the legacy application, so that errors in the recreated program can be corrected.

[0019] Thus the common tokens are used in a relational database where the tokens represent common elements used in all or at least a large number of programs. The database 9 (repository) memory 8 not only stores the tokens, but also preferably stores all of the knowledge databases, the application program interface 5 functions, and the objects methods and business rules of a legacy or new program.

[0020] The application front end can also access the record or database related to a particular legacy program, and document it, e.g. by providing a display or printout of menu-related hierarchy of programs, etc.

[0021] In respect of parsers relating to particular languages:

[0022] Preferably the PowerHouse parser is comprised of four sub-parsers, including the PowerHouse Dictionary Language (PDL), the PowerHouse Reporting language (QUIZ), the PowerHouse batch update language (QTP) and the PowerHouse Forms Language (QDESIGN). Each of these sub-languages includes a separate knowledge base that is used to map the PowerHouse language to the API 5.

[0023] The COBOL parser should reverse engineer ANSI COBOL code including (but not limited to) the Working Storage, Data Division and Procedure Divisions as well as the application logic coded in the legacy application.

[0024] For legacy based applications that use Borland Interbase as a database manager, the Borland Interbase GDML Parser is preferred to be used to recover the design from databases using this technology. The parser is capable of parsing all relational objects that can be defined in a Borland Interbase schema including (but not limited to) Relational tables, Relational Fields, Indexes, Index Segments, Triggers, Procedures as well as Database Views.

[0025] For legacy applications that use ANSI SQL data definition language to create their legacy RDBMS, an ANSI SQL Parser should be used to recover the design from databases using this technology. The parser should parse all relational objects that can be defined in a ANSI SQL schema including Relational tables, Relational Fields, Indexes, Index Segments, Triggers, Procedures as well as Database Views.

[0026] The common dialect of the present embodiment is a language referred to herein as the Chameleon API. The primary purpose of each language parser is to read the legacy source application file and to re-write the legacy code into the Chameleon API language. Once this has been completed, the re-written module is then loaded into the repository using the front end (loader) 7.

5 [0027] The heart of this embodiment is the database 9 repository. This is the area in which all the application and database objects, methods and business rules generated is physically housed.

[0028] The database 9 repository stores information and business rules for business and data services, as well as user interface and appearance control for user services. This environment independent information is preferably stored in an ODBC compliant design database and is intended to be used when building an application. The use of an open repository enables iterative design and reuse and meets multi-developer requirements. Code is generated from design information in the database 9 repository.

[0029] The results of the design activities include a data model, business rules and design information and application preferences which are stored in the database 9 repository.

10 [0030] A database metadata 19 section of the database 9 repository is used to store the data definition attributes of the legacy application. This area of the database 9 repository preferably stores information about the following objects:

Nodes
Database Roles
Databases
20 Domain Drop Downs
Domains
Element Drop Downs
Element Permissions
Elements
25 Index Segments
Indexes
Lookup Tables
Relation Elements
Relation Permissions
30 Relations
Sequences
Stores Procedures
Structures
Template Drop Downs
35 Templates
Trigger Elements
Triggers
User Roles
Users
40 View Sources

[0031] An application Metadata 21 section of the repository is used to store the objects, methods and business rules associated with the legacy application. This area of the database 9 repository stores information about the following objects:

45 Assignment
Blob
Block of Code
Called Module
50 Node
Node Element
Node List
Node Select
Node Sort
55 Comment
Condition
Condition Detail
Coordinate

Core Function
 Core Function Xref
 Core Message
 Cross Reference
 5 Cursor
 Cursor Key
 Database Update
 Event
 Event Detail
 10 External
 Field Property
 Field Value
 Function
 Highlight
 15 Highlight Detail
 Index Segment
 Legacy Source
 Literal
 Log File
 20 Lookup
 Message
 Method
 Module
 Object
 25 Panel
 Panel Graph
 Passing List
 Procedure
 Procedure Detail
 30 Project
 Project Directory
 Receiving List
 Relation
 Relation Access Field
 35 Relation Accesses
 Relation Field
 Relation Index
 Report Section Table
 Report Tables
 40 Screen Property
 Sort Option
 Stack
 Stack Detail
 Stored Procedure
 45 Suminto Operation
 Transaction
 Transaction Relation
 User
 50 Variable

[0032] A knowledge base 23 is a collection of tables that are used to document the grammar of the legacy-based application. This includes documenting the "command" keyword and all its options and the mapping of these to the API 5. This area of the repository should store information about the following objects:

55 API Functions
 API Parameters
 Element Usages
 Functions

	Function Inputs
	Function Options
	Function Results
	General Terms
5	General Term Keywords
	General Term Keyword Options
	Keywords
	Keyword Options
	Keyword Option Defaults
10	Procedures
	Procedure Options
	Verbs
	Verb Options
	Table Types
15	Table Values

- [0033] The primary responsibility of the API loader 7 is to load the intermediary files created by the parsers into the database 9 repository. Each API loader script that is read and parsed should be checked for correctness and validated against the data already loaded. If any conflicts arise, the entire transaction should be rolled back and an error written to a log file. Otherwise, the API loader creates the appropriate objects for the database 9 repository.
- [0034] The engineering interface 13 is for use by application developers to navigate around the various objects and methods of the application; to report on, analyze as well as to refine the extracted business information housed by the database 9 repository. A more detailed block diagram of the preferred form of engineering interface is shown in Figure 2.
- [0035] A database navigator 25 is preferably a Microsoft Explorer™ style interface to the objects that make up the data dictionary and physical database of the legacy application. This interface allows the developer to drill to detail on objects such as relational tables, database views, stored procedures as well as triggers. In addition to the navigational capabilities of this interface, it allows the developer to enhance and modify the underlying physical structure of the database by adding, deleting and modifying the attributes that make up the database component of the legacy application.
- [0036] Similar to the database navigator, an application navigator 27 allows the developer to drill down on the functional modules that make up the application including Screens, Reports and Batch Processes. Using this interface the developer, analysts and end users can quickly pinpoint objects located within the module and make any adjustments necessary. This component also preferably includes an editor, which allows you to view the business rules expressed in your application in, for example, a Microsoft style notepad editor.
- [0037] If the legacy application contains a menu style interface, the engineering interface preferably automatically recreates this system to display or print the hierarchy of the application. This allows IT developers and business users to quickly navigate to the module they need to see at the click of a button.
- [0038] An impact analysis module 29 should provide features that allow assessment of the impacts of making changes to the existing and new application. This module should include an impact analysis navigator as well as provide a number of standard reports that allow review of the impacts based on any object in the database repository. This should include for example the ability to assess the impact of removing database fields, the ability to determine any bottlenecks that may be present in the current application, etc.
- [0039] Because the design recovery process has been automated, the speed at which the information is loaded into the repository is only limited by the speed of the hardware on which this invention operates. In addition, because language specific parsers are used, they must understand the complete grammar of the legacy source language in order for the process to be successful. Because of this, all the important objects, methods and business rules coded in the legacy application should be captured.
- [0040] A forward engineering application 31 is preferably used to rebuild the legacy application, and forward engineer reports, screens and batch processes to a number of computing platforms including PL/SQL, Visual Basic and Dynamic C modules for batch processes.
- [0041] An application designer 17 bridge is preferably also used to load the application directly into Oracle's Designer 2000, once the legacy application has been loaded into the database repository 9.
- [0042] All of the elements 25, 27, 29, 31 and 13 interface the application front end 7 and its window 17, to access the database 9 repository.
- [0043] The invention can be operated on a server preferably comprised of an IBM compatible computer which uses a Pentium I™ or Pentium II™ processor, to which 128 MB of random access memory is coupled, and to which a hard disk drive (or equivalent) is also coupled comprising at least 1 GB of memory space, and on which the programs Windows 95™ or Windows NT™ and Oracle™ 7 or 8 are resident. The repository containing the parsers, knowledge base,

API application front end are stored on the hard disk drive. The engineering interface can be operated by a similar computer which is in communication with the server, the engineering interface being comprised preferably of at least a Pentium I™ or Pentium II™ processor to which 64 MB of random access memory is coupled, and a hard disk drive (or equivalent) with at least 1 GB of memory space. The latter computer preferably also should have Windows 95 or Windows NT 4.0 resident on its hard disk drive. However, other computers and programs can be used, as long as they are capable of carrying out the methods described herein.

EXAMPLE

[0044] The following is a detailed example of processing of a typical PowerHouse source language program file. The example provided represents a typical, but simplified version of a PowerHouse QUIZ program.

[0045] This example provides four QUIZ commands. The first statement indicated that a table named ORDER in the SALES database is to be read. The second statement is the definition of a variable called D_DISCOUNT that is used to calculate a 7% discount on all orders over \$10,000. The third statement is used to identify the information to be printed on the report while the last statement is used to identify the compiled name of the program.

A. SAMPLE QUIZ SOURCE CODE

ACCESS ORDER IN SALES ALIAS SALES_98

[0046]

```
DEFINE D_DISCOUNT NUMERIC * 7 = &
(ORDER_AMT * (7/100)) &
IF ORDER_AMT > 10000 ELSE 0
REPORT ORDER_ID ORDER_AMT D_DISCOUNT
BUILD ORDERREP
```

[0047] The following follows the above example through the various processes that have been described above.

B. KNOWLEDGE BASE DATA/STRUCTURES

[0048] Each parser is created preferably using Yet Another Compiler Compiler (YACC) and a Lexical Analyser (Lex). In addition to these two components, the parsers should incorporate a third component, a knowledge base (KB) to store the mapping of the keywords that make up the various commands in the source language as well as to map to the application programmatic interface (API) functions and parameters that are to be invoked once a grammar rule in YACC has been processed.

[0049] The following section describes four of the main tables that make up the KB.

B.1 KBKEYWORD

[0050] The KBKEYWORD table is used to store all the command keywords in the PowerHouse source language. In this example, there are four command keywords present; **ACCESS, DEFINE, REPORT, BUILD**.

[0051] The KBKEYWORD table is used to store all the keywords available in Powerhouse and is made up of three fields; Yacc_Keyword_Symbol, Keyword_Name and Lookahead_Token. Each of these fields is described as follows:

Yacc_Keyword_Symbol: This field stores the actual command symbol used in the YACC grammar specification. These correspond to the %token commands specified in the grammar file.

Keyword_Name: This field stores contains the actual string found in the legacy source code of the keyword that will be mapped by the Lexical Analyser (Lex). This field is actually used to lookup the token returned by Lex against the KBKeyword table. Once a valid match is encountered, the Yacc_Keyword_Symbol is returned to Yacc by Lex.

Lookahead_Token: This field stores a symbol which represents whether the next token after the keyword is read is an identifier or not.

Yacc_Keyword_Symbol	Keyword_Name	Lookahead_Token
K_ACCESS	Access	IDENTIFIER

B.2 KBKEYWORD OPTION

[0052] The KBKEYWORD_OPTION table is used to store all the keyword options available in the PowerHouse source language for a particular command keyword. In this example, the **ACCESS** statement contains a keyword option called **ALIAS**.

Yacc_Keyword_Symbol: This field stores the actual keyword symbol used in the YACC grammar specification.

Yacc_Option_Symbol: This field stores the actual keyword option symbol used in the YACC grammar specifications that represents an option on a command keyword.

Keyword_Name: This field contains a string representing the Powerhouse Keyword option that is read by Lex. This field is actually used to lookup the token returned by Lex against the KBKeyword_Option table. Once a valid match is encountered, the Yacc_Option_Symbol is returned to Yacc by Lex.

Lookahead_Token: This field stores a symbol which represents whether the next token after the keyword option is read is an identifier or not.

Yacc Keyword Symbol	Yacc Option Symbol	Keyword Option	Lookahead Token
K_ACCESS	ALIAS	Alias	IDENTIFIER
K_ACCESS	ANDX	And	NOTIDENT
K_ACCESS	IN	In	NOTIDENT
K_ACCESS	LINK	Link	NOTIDENT
K_ACCESS	OF	Of	IDENTIFIER
K_ACCESS	OPTIONAL	Optional	NOTIDENT
K_ACCESS	RECORD	Record	NOTIDENT
K_ACCESS	TO	To	NOTIDENT
K_ACCESS	VIAINDEX	Viaindex	NOTIDENT

B.3 KBAPI_FUNCTION

[0053] The KBAPI_FUNCTION table is used to store a mapping of all the API functions that can be called by the Parser. This table is made up of two fields; Api_Function_Symbol and Api_Function_Name. Each of these fields are described as follows:

Api_Function_Symbol: This field stores the actual function symbol used in the API specification. This is the actual field that is used to lookup against this table.

Api_Function_Name: This field stores the name of the API function that is to be invoked by the parser once a grammar rule has been processed.

Api_Function_Symbol	Api_Function_Name
_RPACCESS	iu_rpaccess

B.4 KBAPL_PARAMETER

[0054] The KBAPL_PARAMETER table is used to store a mapping of all the API parameters that are available for a particular API function. This table is made up of four fields;

Api_Function_Symbol, Api_Parameter_Symbol,
Api_Parameter_Name1 and Api_Parameter_Name2.

Api_Function_Symbol: This field stores the actual function symbol used in the YACC grammar specification that represents the function that is being specified.

Api_Parameter_Symbol: This field stores the actual parameter symbol used in the YACC grammar specification that represents the parameter that is being specified.

Api_Parameter_Name1: This field stores the 1st actual parameter name that is to be returned to the YACC grammar.

Api_Parameter_Name2: This field stores the 2nd actual parameter name that is to be returned to the YACC grammar.

Api Function Symbol	Api Parameter Symbol	Api Parameter Name1	Api Parameter Name2
_RPACCESS	_ACCESS_NAME	p_access_name	p_access_name
_RPACCESS	_ALIAS_NAME	p_alias_name	p_alias_name
_RPACCESS	_AUTOCOMMIT_FLAG	p_autocommit_flag	p_autocommit_flag
_RPACCESS	_AUTOLINK_FLAG	p_autolink_flag	p_autolink_flag
_RPACCESS	_BACKWARDS_FLAG	p_backwards_flag	p_backwards_flag
_RPACCESS	_DATABASE	p_database_name	p_database_name
_RPACCESS	_GENERIC_FLAG	p_generic_flag	p_generic_flag
_RPACCESS	_INDEX_NAME	p_index_name	p_index_name
_RPACCESS	_LINKAGE_TYPE	p_linkage_type code	p_linkage_type code
_RPACCESS	_NAME	p_relation_name	p_relation_name
_RPACCESS	_OPTIONAL_FLAG	p_optional_flag	p_optional_flag
_RPACCESS	_ORDER_TYPE_CODE	p_order_type code	p_order_type code
_RPACCESS	_ORDERED_FLAG	p_ordered_flag	p_ordered_flag
_RPACCESS	_PHYSICAL_NAME	p_physical_name	p_physical_name
_RPACCESS	_SEQUENTIAL_FLAG	p_sequential_flag	p_sequential_flag
_RPACCESS	_UNIQUE_FLAG	p_unique_flag	p_unique_flag
_RPACCESS	_WARNING_FLAG	p_nowarn_flag	p_nowarn_flag

C. LANGUAGE GRAMMAR FOR THE QUIZ ACCESS STATEMENT

[0055] The following is a representation of a portion of the grammar that is used to parse and process the ACCESS

statement in the source file of the example given above.

```

5      K_ACCESS data_structure_ref opt_alias
      {
          keyword = _RPACCESS ;

10      /* Don't bother writing out the a iu_rpmodule for the
          first */
          /* access statement as this was beformed by the extended
15      */
          /* BEGIN MODULE rule.
          */

20      ++ctr.access_id;

          ctr.block_seq_no = 0 ;
25      load_block_id(&object_hdr_item, ++ctr.block_id,
          ++ctr.block_seq_no) ;

30      iu_rpaccess(&object_hdr_item, ctr.access_id,
          data_structure_str, $3, NULL, NULL, FALSE,
          physical_file_name, access_subfile_flag) ;

35

40

45

50

55

```

```

primary_relation = current_ohdr;
current_relation = current_ohdr;

}

10 opt_alias:
    /* empty */          { $$ = NULL ; }
    | ALIAS id            { $$ = $2 ; }
    ;

15 data_structure_ref:
    table_ref
    {
20         data_structure_str = encode_data_structure($1,
NULL) ;
        access_subfile_flag = FALSE ;
25         physical_file_name = NULL ;
        $$ = data_structure_str ;
    }
30
    | table_ref IN database_ref
    {
35         data_structure_str = encode_data_structure($1,
$3) ;
        access_subfile_flag = FALSE ;
40         physical_file_name = NULL ;
        $$ = data_structure_str ;
    }
45
    | '*' filespec_ref
    {
        /* Note: physical_file_name set in filespec_ref
50         data_structure_str = encode_data_structure($2,
NULL) ;

```

55

```

    access_subfile_flag = TRUE ;
    $$ = data_structure_str ;
5      }

    | owner_ref '.' table_ref
10      {
        data_structure_str = encode_data_structure($3,
NULL) ;
        access_subfile_flag = FALSE ;
15        physical_file_name = NULL ;
        $$ = data_structure_str ;
    }

20    | owner_ref '.' table_ref IN database_ref
    {
        data_structure_str = encode_data_structure($3,
25    $5) ;
        access_subfile_flag = FALSE ;
        physical_file_name = NULL ;
        $$ = data_structure_str ;
30    }
    ;

35    table_ref:
        id
        { $$ = $1; }
        ;

40    database_ref:
        id
        ;

45    owner_ref:
        id
        ;

50    id:
55

```

```
IDENTIFIER { $$ = $1; }
```

5

;

10 D. C API LIBRARY FOR THE IU_RPACCESS FUNCTION

[0056] The following represents examples of the the C API library that is called by the YACC grammar specification.

```
15  /*-----
    -----*/
    /*-----          iu_raccess() -----
    -----*/
20  /*-----
    -----*/
```

```
25  int iu_raccess( struct object_hdr *p_object_hdr_item, int
    p_access_id, char *p_relation, char *p_alias, char
    *p_linkage_type, char *p_optional, int p_autolink, char
30  *p_physical_name, int p_subfile_flag )
    {
```

```
35  char access_name[MAXFIELDSize] = "" ;
    char database_name[MAXFIELDSize] = "" ;
    char relation_name[MAXFIELDSize] = "" ;
40  char object_name[MAXFIELDSize] = "" ;
```

```
    if (g_debug_switch == 1)
        printf("iu_raccess(p_access_id=%d, p_relation=%s,
45  p_alias=%s, p_linkage_type=%s, p_optional=%s,
        p_autolink=%d, p_physical_name=%s,
        p_subfile_flag=%d)\n",
50  p_access_id, p_relation, p_alias, p_linkage_type,
        p_optional, p_autolink, p_physical_name,
        p_subfile_flag);
```

55

```
    sprintf(access_name, "ACCESS%d", p_access_id) ;
```

```

5      strcpy(relation_name, gettoken(p_relation, '-', _LEFT)) ;

      if ( p_subfile_flag == FALSE )
      {
10         strcpy(database_name, gettoken(gettoken(p_relation, '
', _RIGHT), '-', _LEFT)) ;

         if (strlen(database_name) == 0)
15         {
            /* Check to see if it has already been declared by
looking      */
20            /* up on object_hdr
*/

            strcpy(database_name, lookup_object(relation_name,
25            _RPRELATION, _DATABASE));

            if (strlen(database_name) == 0)
30            strcpy(database_name, "Non Relational") ;
        }
    }
    else
35        strcpy(database_name, "Temporary Data") ;

    if (p_alias == NULL)
40        strcpy(object_name, gettoken(p_relation, '-', _LEFT))
;
    else
45        strcpy(object_name, gettoken(p_alias, '-', _LEFT)) ;

    load_object_hdr(p_object_hdr_item, _QUIZ, _RACCESS,
g_project_name, g_module_name,
50    database_name, gettoken(p_relation, '-', _LEFT),
object_name,
    decode(_OBJECT_TYPE, "rprelation"), _RPRELATION) ;
55

```

```

    push_object_hdr(p_object_hdr_item ) ;

5
    write_obj_detail(_RACCESS, _ACCESS_NAME, access_name,
    _QUOTE) ;

10
    if (p_alias != NULL)
        write_obj_detail(_RACCESS, _ALIAS_NAME, p_alias,
        _QUOTE) ;

15
    if ( p_subfile_flag == TRUE )
    {
        write_obj_detail(_RACCESS, _PHYSICAL_NAME,
20
        p_physical_name , _QUOTE);
        write_obj_detail(_RPRELATION, _RELATION_TYPE,
        decode(_RELATION_TYPE, "subfile") , _QUOTE);
25
    }

    if (p_linkage_type != NULL)
        write_obj_detail(_RACCESS, _LINKAGE_TYPE,
30
        decode(_LINKAGE_TYPE, p_linkage_type) , _QUOTE);

    if (p_optional != NULL)
35
        write_obj_detail(_RACCESS, _OPTIONAL_FLAG,
        decode(_FLAG, p_optional), _QUOTE);

    if (p_autolink == TRUE)
40
        write_obj_detail(_RACCESS, _AUTOLINK_FLAG,
        decode(_FLAG, "TRUE"), _QUOTE);

45
        write_obj_detail(_RPMETHOD, _METHOD_TYPE,
        decode(_METHOD_TYPE, "retrieve"), _QUOTE);

    return 1 ;

50
}

55

```



```

/* -----
5 -----*/
/* ----- load_object_hdr() -----
-----*/
/* -----
10 -----*/

load_object_hdr(struct object_hdr *p_object_hdr_item,
15         int p_module_type,
         int p_keyword_symbol,
         char *p_project_name,
         char *p_module_name,
20         char *p_database_name,
         char *p_relation_name,
         char *p_object_name,
         char *p_object_type_code,
25         int p_object_type)
{
    register int v_mid;
30

    if (g_debug_switch == 1)
        printf("load_object_hdr(p_module_type=%d,
35         p_keyword_symbol=%d, p_project_name=%s,
         p_module_name=%s, p_database_name=%s,
         p_relation_name=%s, p_object_name=%s,
         p_object_type_code=%s, p_object_type=%d)\n",
40         p_module_type, p_keyword_symbol, p_project_name,
         p_module_name, p_database_name, p_relation_name,
         p_object_name,
45         p_object_type_code, p_object_type);

    v_mid = get_api_function(p_keyword_symbol);

50     if (g_first_ohdr_created == FALSE)
    {
55

```

```

/* create the first object header record. */

5      g_object_id = 1;
      g_object_seq_no = 0;
      ++g_object_hdr_count;
10     g_first_hdr_created = TRUE;
    }
    else
    {
15     g_object_id++;
      g_object_seq_no = 0;
      g_object_hdr_count++;
20   }

      store_object_hdr(p_object_hdr_item, _OBJECT_ID, NULL,
g_object_id) ;
25     store_object_hdr(p_object_hdr_item, _API_FUNCTION,
api_function[v_mid].api_function_name, -1) ;

30   if (p_module_type == _QUIZ)
    {

      store_object_hdr(p_object_hdr_item, _PROJECT_NAME,
35     p_project_name, -1) ;
      store_object_hdr(p_object_hdr_item, _MODULE_NAME,
p_module_name, -1) ;

40     if ( gl_file_stack_pointer > 0 )
      store_object_hdr(p_object_hdr_item,
_ORIGINATING_MODULE, originating_module, -1) ;

45     store_object_hdr(p_object_hdr_item, _DATABASE_NAME,
p_database_name, -1) ;
      store_object_hdr(p_object_hdr_item, _RELATION_NAME,
50     p_relation_name, -1) ;

```

55

```

        store_object_hdr(p_object_hdr_item, _OBJECT_NAME,
5      p_object_name, -1) ;
        store_object_hdr(p_object_hdr_item, _OBJECT_TYPE_CODE,
        p_object_type_code, -1) ;
        store_object_hdr(p_object_hdr_item, _OBJECT_TYPE,
10     NULL, p_object_type) ;
    }

    return 1 ;
15 }

/*-----
-----*/
20 /*----- store_object_hdr() -----
-----*/
/*-----
-----*/
25

int store_object_hdr(struct object_hdr *p_object_hdr_item,
30 int p_object_hdr_type, char *p_char_value, int p_int_value)
{
35     char *object_hdr_value ;

    if ( g_debug_switch == 1 )
        printf("store_object_hdr_item(p_object_hdr_type=%d,
40     p_char_value=%s, p_int_value=%d)\n",
        p_object_hdr_type, p_char_value, p_int_value) ;

    if ( p_char_value != NULL )
    {
        object_hdr_value =
50     malloc(strlen(gettoken(p_char_value, '-', _LEFT)) + 1) ;
        strcpy(object_hdr_value, gettoken(p_char_value, '-',
        _LEFT)) ;
55

```

```

    }

5      switch ( p_object_hdr_type )
    {
        case _OBJECT_ID:
10         p_object_hdr_item->object_id = p_int_value ;
            break ;

        case _API_FUNCTION:
15
            p_object_hdr_item->api_function =
                malloc(strlen(object_hdr_value) + 1) ;
20             strcpy(p_object_hdr_item->api_function,
                object_hdr_value) ;

                break ;

25         case _PROJECT_NAME:

            p_object_hdr_item->project_name =
30             malloc(strlen(object_hdr_value) + 1) ;
            strcpy(p_object_hdr_item->project_name,
                object_hdr_value) ;
35
            break ;

        case _MODULE_NAME:
40
            p_object_hdr_item->module_name =
                malloc(strlen(object_hdr_value) + 1) ;
45             strcpy(p_object_hdr_item->module_name,
                object_hdr_value) ;

            break ;
50

        case _ORIGINATING_MODULE:

55

```

```

    p_object_hdr_item->originating_module =
5      malloc(strlen(object_hdr_value) + 1) ;
      strcpy(p_object_hdr_item->originating_module,
object_hdr_value) ;

10      break ;

      case _OBJECT_NAME:

15      p_object_hdr_item->object_name =
      malloc(strlen(object_hdr_value) + 1) ;
      strcpy(p_object_hdr_item->object_name,
20      object_hdr_value) ;

      break ;

25      case _OBJECT_TYPE_CODE:

      p_object_hdr_item->object_type_code =
30      malloc(strlen(object_hdr_value) + 1) ;
      strcpy(p_object_hdr_item->object_type_code,
object_hdr_value) ;

35      break ;

      case _DATABASE_NAME:

40      p_object_hdr_item->database_name =
      malloc(strlen(object_hdr_value) + 1) ;
      strcpy(p_object_hdr_item->database_name,
45      object_hdr_value) ;

      break ;

50      case _RELATION_NAME:
```

```

    p_object_hdr_item->relation_name =
5   malloc(strlen(object_hdr_value) + 1) ;
    strcpy(p_object_hdr_item->relation_name,
object_hdr_value) ;

10   break ;

    case _OCCURS_VALUE:

15   p_object_hdr_item->occurs =
    malloc(strlen(object_hdr_value) + 1) ;
    strcpy(p_object_hdr_item->occurs, object_hdr_value)
20   ;

    break ;

25   case _BLOCK_ID:
    p_object_hdr_item->block_id = p_int_value ;
    break ;

30   case _BLOCK_SEQ_NO:
    p_object_hdr_item->block_seq_no = p_int_value ;
    break ;

35   case _PANEL_ID:
    p_object_hdr_item->panel_id = p_int_value ;
    break ;

40   case _OBJECT_TYPE:
    p_object_hdr_item->object_type = p_int_value ;
    break ;

45   case _OBJECT_DTL_COUNT:
    p_object_hdr_item->object_dtl_count = p_int_value ;
    break ;

50   case _OBJECT_DTL_COUNT:
    p_object_hdr_item->object_dtl_count = p_int_value ;
    break ;

55

```

```

        case _INCLUDE_MODULE_FLAG:
            p_object_hdr_item->include_module_flag =
5         p_int_value ;
            break ;

10         default:
            break ;

15     }

    return 1 ;
}

20
/* -----
-----*/
/* ----- print_obj_header() -----
25 -----*/
/* -----
-----*/

30
void print_obj_header(char *p_filespec_str)
{
    struct object_hdr *ohdr = first_ohdr;
35     int object_count = 0;
    int obj_type = 0 ;

40     char *p_compiled_name ;

    long time(), tm = time((long *)0);
    char *ctime();

45     char block_name[MAXFIELD_SIZE] = "" ;
    char block_seq_no[MAXFIELD_SIZE] = "" ;

50     if (g_debug_switch == 1)

```

```

    printf("print_obj_header()\n");
5
    if ( p_filespec_str != NULL )
    {
        if ( strlen(gettoken(p_filespec_str, ':', _RIGHT)) ==
10
        0)
            p_compiled_name = p_filespec_str ;
        else
            p_compiled_name = gettoken(p_filespec_str, ':',
15
            _RIGHT) ;
    }

    fprintf (coreout, "--\n");
    fprintf (coreout, "-- CORE SOFTWARE CORP. (R) 32-bit
20
    PowerHouse %s Parser %s for 80x86 \n",
        core_parser, core_version);
    fprintf (coreout, "-- Copyright (C) CORE SOFTWARE CORP.
25
    1997-1998. Patent Pending.\n");
    fprintf (coreout, "-- All rights reserved.\n");
    fprintf (coreout, "--\n");
    fprintf (coreout, "-- Automatically generated on: %s",
30
    ctime(&tm));
    fprintf (coreout, "--          ...was generated by:
35
    garrywh\n");
    fprintf (coreout, "--          ...with version: %s
    (%s)\n", core_parser, core_version);
    fprintf (coreout, "--\n\n");
40
    do
    {
65
        ++g_commit_count ;
        ++object_count ;

50
        sprintf(block_name, "BLOCK%d", ohdr->block_id) ;
        sprintf(block_seq_no, "%d", ohdr->block_seq_no) ;
55

```



```

obj_type = ohdr->object_type ;

5      if (g_commit_count == 1) .
      {
          fprintf(coreout, "Begin\n");
10     }

      fprintf(coreout, " %s\n", ohdr->api_function);
15     fprintf(coreout, " (\n");

      /* Print the column name and value. Logic added to
      control when the */
20     /* comma is printed at the end of the line. If at
      least one detail */
      /* record exists, then print the line, otherwise check
      to see if */
25     /* the next line is to be printed.
      */

30     /* always (mandatory) need at least a project name */

      if (ohdr->object_type == _RPPROJECT)
      {
35         /* when printing the project, no comma is required
          */
          if ( ohdr->project_name != NULL )
          fprintf(coreout, "      p_project_name=>'%s'\n",
40         ohdr->project_name);
          }

45     else
      {
          if ( ohdr->project_name != NULL )
          fprintf(coreout, "      p_project_name=>'%s',\n",
50         ohdr->project_name);
      }

```

55

```

    }

5
    /* if not the _RPPROJECT record, then module name is
    (mandatory) */
    /* (but not for PDL */
10
    if (ohdr->object_type != _RPPROJECT)
    {
15
        if ( ohdr->object_type == _RPMODULE )
        {
            /* As the API is creating ohdr records, it
            stamps the module_name */
20
            /* with the source file name (i.e., BF013.QZS).
            When is comes time */

            /* to generate the API (after parsing),
            determine if a BUILD statement */
25
            /* was encountered by the parser. If so, the
            module_name becomes the */

            /* name (compiled) supplied on the BUILD
            statement. If the module */
30
            /* record was created from a BEGIN INCLUDE
            statement, then the */

            /* module name is the name of the INCLUDE file
            */
35

            if ( ohdr->include_module_flag == TRUE )
            {
40
                fprintf(coreout, "
                p_module_name=>'s',\n", ohdr->module_name);
            }
            else
            {
45
                fprintf(coreout, "
                p_module_name=>'s',\n", p_compiled_name);
            }
            else
            {
50
                if ( p_filespec_str != NULL )
                {
55

```

```

    fprintf(coreout, "
5   p_module_name=>'%s',\n", p_compiled_name);
    }
    }

10   if ( ohdr->originating_module != NULL )
    {
        /* print the originating module */
        if (strlen(ohdr->originating_module) > 0)
15     {
            if ((ohdr->object_dtl_count > 0) ||
                (strlen(ohdr->relation_name) > 0))
20         fprintf(coreout, "
            p_originating_module_name=>'%s',\n", ohdr-
                >originating_module);
            else
25         fprintf(coreout, "
            p_originating_module_name=>'%s'\n", ohdr-
                >originating_module);
30     }
    }

    /* _RPRPROJECT and _RPMODULE object records cannot
35   have any additional properties */

    if (ohdr->object_type != _RPRPROJECT && ohdr-
40   >object_type != _RPMODULE)
    {

        if (strlen(ohdr->object_name) > 0)
45     {
            if ((ohdr->object_dtl_count > 0) ||
                (strlen(ohdr->object_type_code) > 0))
50         fprintf(coreout, "
            p_object_name=>'%s',\n", ohdr->object_name);
            else
55

```

```

        fprintf(coreout, "
5      p_object_name=>'s'\n", ohdr->object_name);
    }

    if (strlen(ohdr->object_type_code) > 0)
10    {
        if (ohdr->object_dtl_count > 0)
            fprintf(coreout, "
                p_object_type_code=>'s',\n", ohdr->object_type_code);
15        else
            fprintf(coreout, "
                p_object_name=>'s'\n", ohdr->object_type_code);
20    }

    /* print the database_name property */
    if (strlen(ohdr->database_name) > 0)
25    {
        if ((ohdr->object_dtl_count > 0) ||
            (strlen(ohdr->relation_name) > 0))
            fprintf(coreout, "
30        p_database_name=>'s',\n", ohdr->database_name);
        else
            fprintf(coreout, "
35        p_database_name=>'s'\n", ohdr->database_name);
    }

    /* print the relation_name property */
40    if (strlen(ohdr->relation_name) > 0)
    {
        if ((ohdr->object_dtl_count > 0) ||
45        (strlen(ohdr->object_name) > 0))
            fprintf(coreout, "
                p_relation_name=>'s',\n", ohdr->relation_name);
        else
50        fprintf(coreout, "
                p_relation_name=>'s'\n", ohdr->relation_name);
55

```

```

    }

5       if ( ohdr->block_id > 0)
    {
        if ((ohdr->object_dtl_count > 0) ||
10      (strlen(ohdr->object_type_code) > 0))
            fprintf(coreout, "
p_block_name=>'s',\n", block_name);
        else
15      fprintf(coreout, "      p_block_name=>'s'\n",
block_name);
    }

20      if ( ohdr->block_seq_no > 0)
    {
        if ((ohdr->object_dtl_count > 0) ||
25      (strlen(ohdr->object_type_code) > 0))
            fprintf(coreout, "
p_block_sequence_number=>s,\n", block_seq_no);
        else
30      fprintf(coreout, "
p_block_sequence_number=>s\n", block_seq_no);
    }

35      }

    /* now, print the details */
40      print_obj_detail(ohdr->firstdtl, ohdr->object_id,
ohdr->object_dtl_count);

45      fprintf(coreout, " );\n");
    if (g_commit_count == g_commit_point || ohdr->next ==
NULL)
50      {
        fprintf(coreout, "End;\n");
        fprintf(coreout, "/\n\n");
55

```

```

        g_commit_count = 0;
    }
5    } while ((ohdr = ohdr->next) != NULL);
    }

```

10

E. INTERMEDIARY API FILE

15 [0057] Once a parser has successfully processed the source file, the following Intermediary API file is generated for the above example by the parser. This file will later be used by the API Loader described later.

```

20    Begin
        iu_rpproject
        (
            p_project_name=>'Sales History'
25        );
    End;
    /

30    Begin
        iu_rpmodule
        (
35            p_project_name=>'Sales History',
            p_module_name=>'ORDERREP',
            p_module_type_code=>'0002',
40            p_module_source=>'orderrep.qzs',
            p_module_sequence_number=>1
        );
45    End;
    /

50    Begin
        iu_rpblob
        (

```

55

```

    p_project_name=>'Sales History',
    p_module_name=>'ORDERREP',
5      p_filedir=>'C:\Clients\CSC\RPData',
    p_filename=>'orderrep.qzs'
  );
10  End;
/

Begin
15    iu_rpaccess
  (
    p_project_name=>'Sales History',
    p_module_name=>'ORDERREP',
20    p_object_name=>'SALES_98',
    p_object_type_code=>'0039',
    p_block_name=>'BLOCK1',
25    p_block_sequence_number=>1,
    p_database_name=>'SALES',
    p_relation_name=>'ORDER',
    p_access_name=>'ACCESS1',
30    p_alias_name=>'SALES_98',
    p_method_type_code=>'0012'
  );
35  End;
/

Begin
40    iu_rpvariable
  (
    p_project_name=>'Sales History',
    p_module_name=>'ORDERREP',
45    p_object_name=>'D_DISCOUNT',
    p_object_type_code=>'0054',
    p_block_name=>'BLOCK2',
50    p_block_sequence_number=>1,
    p_variable_name=>'D_DISCOUNT',
55

```

```

5      p_variable_type=>'0013',
      p_item_datatype_code=>'0013',
      p_variable_size=>'7',
      p_signed_flag=>'0002',
      p_method_type_code=>'0005'
10    );
End;
/

15 Begin
    iu_rpprocedure
    (
20      p_project_name=>'Sales History',
      p_module_name=>'ORDERREP',
      p_object_name=>'PROCEDURE1',
      p_object_type_code=>'0034',
25      p_block_name=>'BLOCK2',
      p_block_sequence_number=>2,
      p_variable_name=>'D_DISCOUNT',
      p_procedure_name=>'PROCEDURE1',
30      p_event_flag=>'0002',
      p_source_procedure_type_code=>'0007',
      p_method_type_code=>'0001'
35    );
End;
/

40 Begin
    iu_rpevent_detail
    (
45      p_project_name=>'Sales History',
      p_module_name=>'ORDERREP',
      p_object_name=>'PROCEDURE1',
      p_object_type_code=>'0034',
50      p_block_name=>'BLOCK2',
      p_block_sequence_number=>2,
55

```



```

    p_procedure_name=>'PROCEDURE1',
    p_event_name=>'EVENT1',
5    p_event_sequence_number=>1,
    p_condition_name=>'CONDITION1',
    p_event_type_code=>'0001',
    p_nesting_level=>1,
10    p_token=>'if',
    p_token_type_code=>'0030',
    p_method_type_code=>'0001'
15    );
End;
/

20    Begin
        iu_rpcondition_detail
        (
25            p_project_name=>'Sales History',
            p_module_name=>'ORDERREP',
            p_object_name=>'PROCEDURE1',
            p_object_type_code=>'0034',
30            p_block_name=>'BLOCK2',
            p_block_sequence_number=>2,
            p_procedure_name=>'PROCEDURE1',
            p_condition_name=>'CONDITION1',
35            p_condition_sequence_number=>1,
            p_stack_name=>'STACK1',
            p_method_type_code=>'0004'
40        );
End;
/

45    Begin
        iu_rpstack
        (
50            p_project_name=>'Sales History',
            p_module_name=>'ORDERREP',
55

```

```

    p_object_name=>'PROCEDURE1',
    p_object_type_code=>'0034',
    p_block_name=>'BLOCK2',
    p_block_sequence_number=>2,
    p_stack_name=>'STACK1',
    p_method_type_code=>'0001'
);
End;
/

Begin
    iu_rpstack_detail
    (
        p_project_name=>'Sales History',
        p_module_name=>'ORDERREP',
        p_object_name=>'ORDER_AMT',
        p_object_type_code=>'0040',
        p_block_name=>'BLOCK2',
        p_block_sequence_number=>2,
        p_element_name=>'ORDER_AMT',
        p_get_relation_flag=>'0001',
        p_stack_name=>'STACK1',
        p_stack_sequence_number=>1,
        p_token=>'ORDER_AMT',
        p_token_type_code=>'0020',
        p_method_type_code=>'0001'
    );
End;
/

Begin
    iu_rpstack_detail
    (
        p_project_name=>'Sales History',
        p_module_name=>'ORDERREP',
        p_block_name=>'BLOCK2',

```

```

5         p_block_sequence_number=>2,
          p_stack_name=>'STACK1',
          p_stack_sequence_number=>2,
          p_token=>'>',
          p_token_type_code=>'0016',
10         p_method_type_code=>'0001'
      );
End;
/
15

Begin
    iu_rpstack_detail
20    (
        p_project_name=>'Sales History',
        p_module_name=>'ORDERREP',
        p_object_name=>'LITERAL1',
25        p_object_type_code=>'0022',
        p_block_name=>'BLOCK2',
        p_block_sequence_number=>2,
        p_literal_name=>'LITERAL1',
30        p_text_value=>'10000',
        p_stack_name=>'STACK1',
        p_stack_sequence_number=>3,
35        p_token=>'10000',
        p_token_type_code=>'0019',
        p_method_type_code=>'0001'
    );
40 End;
/

45 Begin
    iu_rpevent_detail
    (
        p_project_name=>'Sales History',
50        p_module_name=>'ORDERREP',
        p_object_name=>'PROCEDURE1',
55

```

```

5      p_object_type_code=>'0034',
      p_block_name=>'BLOCK3',
      p_block_sequence_number=>2,
      p_procedure_name=>'PROCEDURE1',
10     p_event_name=>'EVENT1',
      p_event_sequence_number=>2,
      p_event_type_code=>'0002',
      p_nesting_level=>1,
15     p_related_block_name=>'BLOCK2',
      p_related_block_sequence_number=>'3',
      p_token=>'then',
      p_token_type_code=>'0031',
20     p_method_type_code=>'0001'
    );
End;
/

25
Begin
    iu_rpassgment
    (
30     p_project_name=>'Sales History',
      p_module_name=>'ORDERREP',
      p_object_name=>'D_DISCOUNT',
35     p_object_type_code=>'0054',
      p_block_name=>'BLOCK3',
      p_block_sequence_number=>3,
      p_variable_name=>'D_DISCOUNT',
40     p_assignment_type_code=>'0003',
      p_assignment_name=>'ASSIGN1',
      p_stack_name=>'STACK2',
45     p_method_type_code=>'0002'
    );
End;
/

50
Begin

```

55

```

iu_rpstack
(
5      p_project_name=>'Sales History',
      p_module_name=>'ORDERREP',
      p_object_name=>'D_DISCOUNT',
10     p_object_type_code=>'0054',
      p_block_name=>'BLOCK3',
      p_block_sequence_number=>3,
      p_variable_name=>'D_DISCOUNT',
15     p_stack_name=>'STACK2',
      p_method_type_code=>'0001'
);
End;
20 /

Begin
iu_rpstack_detail
(
      p_project_name=>'Sales History',
      p_module_name=>'ORDERREP',
30     p_block_name=>'BLOCK3',
      p_block_sequence_number=>3,
      p_stack_name=>'STACK2',
      p_stack_sequence_number=>1,
35     p_token=>'(',
      p_token_type_code=>'0006',
      p_method_type_code=>'0001'
40 );
End;
/
45

Begin
iu_rpstack_detail
(
50     p_project_name=>'Sales History',
      p_module_name=>'ORDERREP',
55

```

```

        p_block_name=>'BLOCK3',
        p_block_sequence_number=>3,
5         p_stack_name=>'STACK2',
        p_stack_sequence_number=>2,
        p_token=>'(',
10        p_token_type_code=>'0006',
        p_method_type_code=>'0001'
    );
End;
15 /

Begin
    iu_rpstack_detail
20    (
        p_project_name=>'Sales History',
        p_module_name=>'ORDERREP',
25        p_object_name=>'ORDER_AMT',
        p_object_type_code=>'0040',
        p_block_name=>'BLOCK3',
        p_block_sequence_number=>3,
30        p_element_name=>'ORDER_AMT',
        p_get_relation_flag=>'0001',
        p_stack_name=>'STACK2',
        p_stack_sequence_number=>3,
35        p_token=>'ORDER_AMT',
        p_token_type_code=>'0020',
        p_method_type_code=>'0001'
    );
End;
40 /

Begin
    iu_rpstack_detail
50    (
        p_project_name=>'Sales History',
        p_module_name=>'ORDERREP',
55

```

```

        p_block_name=>'BLOCK3',
        p_block_sequence_number=>3,
5      p_stack_name=>'STACK2',
        p_stack_sequence_number=>4,
        p_token=>'*',
10     p_token_type_code=>'0010',
        p_method_type_code=>'0001'
    );
End;
15 /

Begin
    iu_rpstack_detail
20  (
        p_project_name=>'Sales History',
        p_module_name=>'ORDERREP',
        p_object_name=>'LITERAL2',
25     p_object_type_code=>'0022',
        p_block_name=>'BLOCK3',
        p_block_sequence_number=>3,
        p_literal_name=>'LITERAL2',
        p_text_value=>'100',
        p_stack_name=>'STACK2',
        p_stack_sequence_number=>5,
30     p_token=>'100',
        p_token_type_code=>'0019',
        p_method_type_code=>'0001'
    );
End;
/
45

Begin
    iu_rpstack_detail
50  (
        p_project_name=>'Sales History',
        p_module_name=>'ORDERREP',
55

```

```

    p_block_name=>'BLOCK3',
    p_block_sequence_number=>3,
    p_stack_name=>'STACK2',
    p_stack_sequence_number=>6,
    p_token=>')',
    p_token_type_code=>'0007',
    p_method_type_code=>'0001'
);
End;
/

Begin
    iu_rpstack_detail
    (
        p_project_name=>'Sales History',
        p_module_name=>'ORDERREP',
        p_block_name=>'BLOCK3',
        p_block_sequence_number=>3,
        p_stack_name=>'STACK2',
        p_stack_sequence_number=>7,
        p_token=>'/ ',
        p_token_type_code=>'0011',
        p_method_type_code=>'0001'
    );
End;
/

Begin
    iu_rpstack_detail
    (
        p_project_name=>'Sales History',
        p_module_name=>'ORDERREP',
        p_object_name=>'LITERAL3',
        p_object_type_code=>'0022',
        p_block_name=>'BLOCK3',
        p_block_sequence_number=>3,

```



```

    p_literal_name=>'LITERAL3',
    p_text_value=>'100',
5      p_stack_name=>'STACK2',
    p_stack_sequence_number=>8,
    p_token=>'100',
10     p_token_type_code=>'0019',
    p_method_type_code=>'0001'
  );
End;
15  /

Begin
    iu_rptest_detail
20     (
        p_project_name=>'Sales History',
        p_module_name=>'ORDERREP',
        p_block_name=>'BLOCK3',
25     p_block_sequence_number=>3,
        p_stack_name=>'STACK2',
        p_stack_sequence_number=>9,
30     p_token=>')',
        p_token_type_code=>'0007',
        p_method_type_code=>'0001'
35     );
End;
/

40  Begin
    iu_rpevent_detail
    (
45     p_project_name=>'Sales History',
        p_module_name=>'ORDERREP',
        p_object_name=>'PROCEDURE1',
        p_object_type_code=>'0034',
50     p_block_name=>'BLOCK4',
        p_block_sequence_number=>4,
55

```

```

5      p_procedure_name=>'PROCEDURE1',
      p_event_name=>'EVENT1',
      p_event_sequence_number=>3,
      p_event_type_code=>'0003',
      p_nesting_level=>1,
10     p_related_block_name=>'BLOCK2',
      p_related_block_sequence_number=>'5',
      p_token=>'else',
      p_token_type_code=>'0032',
15     p_method_type_code=>'0001'
    );
End;
/

20
Begin
    iu_rpassgment
    (
25     p_project_name=>'Sales History',
      p_module_name=>'ORDERREP',
      p_object_name=>'D_DISCOUNT',
30     p_object_type_code=>'0054',
      p_block_name=>'BLOCK4',
      p_block_sequence_number=>5,
35     p_variable_name=>'D_DISCOUNT',
      p_assignment_type_code=>'0003',
      p_assignment_name=>'ASSIGN2',
40     p_stack_name=>'STACK3',
      p_method_type_code=>'0002'
    );
End;
/

45
Begin
    iu_rpstack
50     (
      p_project_name=>'Sales History',

```

55

```

    p_module_name=>'ORDERREP',
    p_object_name=>'D_DISCOUNT',
    p_object_type_code=>'0054',
    p_block_name=>'BLOCK4',
    p_block_sequence_number=>5,
    p_variable_name=>'D_DISCOUNT',
    p_stack_name=>'STACK3',
    p_method_type_code=>'0001'
);
End;
/

Begin
    iu_rpstack_detail
    (
        p_project_name=>'Sales History',
        p_module_name=>'ORDERREP',
        p_object_name=>'LITERAL4',
        p_object_type_code=>'0022',
        p_block_name=>'BLOCK4',
        p_block_sequence_number=>5,
        p_literal_name=>'LITERAL4',
        p_text_value=>'0',
        p_stack_name=>'STACK3',
        p_stack_sequence_number=>1,
        p_token=>'0',
        p_token_type_code=>'0019',
        p_method_type_code=>'0001'
    );
End;
/

Begin
    iu_rppanel
    (
        p_project_name=>'Sales History',

```

```

5      p_module_name=>'ORDERREP',
      p_object_name=>'PANEL1',
      p_object_type_code=>'0030',
      p_block_name=>'BLOCK5',
      p_block_sequence_number=>1,
10     p_panel_name=>'PANEL1',
      p_panel_type_code=>'0011',
      p_method_type_code=>'0001'

      );
15     End;
    /

20     Begin
        iu_rpfld_property
        (
            p_project_name=>'Sales History',
25         p_module_name=>'ORDERREP',
            p_object_name=>'ORDER_ID',
            p_object_type_code=>'0040',
            p_block_name=>'BLOCK5',
            p_block_sequence_number=>2,
30         p_element_name=>'ORDER_ID',
            p_get_relation_flag=>'0001',
            p_panel_name=>'PANEL1',
35         p_field_property_name=>'PROPERTY1',
            p_method_type_code=>'0006'

        );
40     End;
    /

45     Begin
        iu_rpcoordinate
        (
            p_project_name=>'Sales History',
50         p_module_name=>'ORDERREP',
            p_object_name=>'PROPERTY1',

```

55

```

    p_object_type_code=>'0015',
    p_block_name=>'BLOCK5',
5      p_block_sequence_number=>2,
    p_coordinate_name=>'COORDINATE1',
    p_property_name=>'PROPERTY1',
10     p_coordinate_type_code=>'0004',
    p_start_row=>1
  );
End;
15 /

Begin
    iu_rpfield_property
20   (
        p_project_name=>'Sales History',
        p_module_name=>'ORDERREP',
25     p_object_name=>'ORDER_AMT',
        p_object_type_code=>'0040',
        p_block_name=>'BLOCK5',
30     p_block_sequence_number=>3,
        p_element_name=>'ORDER_AMT',
        p_get_relation_flag=>'0001',
        p_panel_name=>'PANEL1',
35     p_field_property_name=>'PROPERTY2',
        p_method_type_code=>'0006'
    );
40 End;
/

Begin
45     iu_rpcoordinate
    (
        p_project_name=>'Sales History',
        p_module_name=>'ORDERREP',
50     p_object_name=>'PROPERTY2',
        p_object_type_code=>'0015',
55

```

```

      p_block_name=>'BLOCK5',
      p_block_sequence_number=>3,
      p_coordinate_name=>'COORDINATE2',
      p_property_name=>'PROPERTY2',
      p_coordinate_type_code=>'0004',
      p_start_row=>1
    );
  End;
/

Begin
  iu_rpfield_property
  (
    p_project_name=>'Sales History',
    p_module_name=>'ORDERREP',
    p_object_name=>'D_DISCOUNT',
    p_object_type_code=>'0054',
    p_block_name=>'BLOCK5',
    p_block_sequence_number=>4,
    p_variable_name=>'D_DISCOUNT',
    p_panel_name=>'PANEL1',
    p_field_property_name=>'PROPERTY3',
    p_method_type_code=>'0006'
  );
End;
/

Begin
  iu_rpcoordinate
  (
    p_project_name=>'Sales History',
    p_module_name=>'ORDERREP',
    p_object_name=>'PROPERTY3',
    p_object_type_code=>'0015',
    p_block_name=>'BLOCK5',
    p_block_sequence_number=>4,

```

```

    p_coordinate_name=>'COORDINATE3',
    p_property_name=>'PROPERTY3',
    p_coordinate_type_code=>'0004',
    p_start_row=>1
  );
End;
/

```

F. Data Model for Access & Access Field

[0058] Figure 3 shows a representation of the portion of the data model that encompasses the ACCESS and ACCESS_FIELDS relations. These entities in the CORE Repository are used to store the information that will be used to regenerate the data selection criteria for the target environment.

G. Oracle API Source Code

[0059] The following sample API includes the structure and functionality inherent in the remainder of the APIs. Each API is programmed with the capability to determine if the action to be executed is an Insert action or an Update action. Prior to actually performing the required action, the API's will perform a number of validation steps that establish the relationship between the current Object and the remainder of the objects already stored in the CORE repository.

```

CREATE OR REPLACE PROCEDURE IU_RPAccess (
  p_Project_Name
  RPPProject.Project_Name%type default null,
  p_Module_Name
  RPModule.Module_Name%type default null,

```

```

5      p_Originating_Module_Name      RPModule.Module_Name%type
default null,
      p_Database_Name
      DBDatabase.Database_Name%type default null,
      p_Relation_Name
10     DBRelation.Relation_Name%type default null,
      p_Object_Name
      RPObject.Object_Name%type default null,
      p_Object_Type_Code
15     RPObject.Object_Type_Code%type default null,
      p_method_type_code
      RPMethod.Method_Type_code%type default null,
20     p_Debug_switch                  Varchar2 default
null,
      p_Alias_Name
      RPAccess.Alias_Name%type default ' ',
25     p_Physical_Name
      DBRelation.Physical_Name%type default null,
      p_Relation_type_code
      DBRelation.Relation_Type_Code%type default Null ,
30     p_Access_Name
      RPAccess.Access_Name%Type default Null,
      p_Stack_name
      RPStack.Stack_Name%Type Default null,
35     p_Index_Name
      RPStack.Stack_name%Type Default null,
      p_Project_ID
40     RPAccess.Project_ID%type default null,
      p_Module_ID
      RPAccess.Module_ID%type default null,
45     p_Originating_Module_ID
      RPAccess.Originating_Module_ID%type default null,
      p_Object_ID
      RPAccess.Object_ID%type default null,
50     p_Method_ID
      RPAccess.Method_ID%type default null,

```

55


```

p_Access_ID
5   RPAccess.Access_ID%type default null,
p_Database_ID
   RPAccess.Database_ID%type default Null ,
p_Relation_ID
10  RPAccess.Relation_ID%type default Null ,
p_Block_ID
   RPAccess.Block_ID%type default Null ,
15  p_Block_Name
   RPCode_Block.Block_Name%type default null,
   p_Block_sequence_Number
RPMMethod.Block_sequence_Number%type default 0,
20  p_Linkage_type_code
   RPAccess.Linkage_type_code%type default Null ,
   p_Backward_Flag
   RPAccess.Backward_Flag%type default Null ,
25  p_Generic_Flag
   RPAccess.Generic_Flag%type default Null ,
   p_Optional_Flag
   RPAccess.Optional_Flag%type default Null ,
30  p_Order_Type_Code
   RPAccess.Order_Type_Code%type default Null ,
   p_Sequential_Flag
35  RPAccess.Sequential_Flag%type default Null ,
   p_Unique_Flag
   RPAccess.Unique_Flag%type default Null ,
40  p_Autocommit_Flag
   RPAccess.Autocommit_Flag%type default Null ,
   p_Autolink_Flag
   RPAccess.Autolink_Flag%type default Null ,
45  p_Nowarn_Flag
   RPAccess.Nowarn_Flag%type default Null ,
   p_Lock_Type_Code
   RPAccess.Lock_Type_Code%type default Null ,
50  p_Index_ID
   RPAccess.Index_ID%type default Null ,
55

```

```

5      p_Stack_ID
      RPAccess.Stack_ID%type default null,
      p_Audit_Creation_Date
      RPAccess.Audit_Creation_Date%type default Null ,
      p_Audit_Modified_Date
10     RPAccess.Audit_Modified_Date%type default Null ,
      p_Audit_Update_Type_Code
      RPAccess.Audit_Update_Type_Code%type default Null ,
15     p_Audit_Who
      RPAccess.Audit_Who%type default Null ,
      p_Audit_Where
      RPAccess.Audit_Where%type default Null ) IS
20
      t_Project_ID
      RPAccess.Project_ID%type;
      t_Module_ID
25     RPAccess.Module_ID%type;
      t_Originating_Module_ID
      RPAccess.Originating_Module_ID%type;
30     t_Object_ID
      RPAccess.Object_ID%type;
      t_Method_ID
      RPAccess.Method_ID%type;
35     t_Database_ID
      RPAccess.Database_ID%type;
      t_Relation_ID
40     RPAccess.Relation_ID%type;
      t_Block_ID
      RPAccess.Block_ID%type default 0 ;
45     t_Procedure_ID
      RPAccess.Block_ID%type default 0 ;
      t_Index_ID
      RPAccess.Index_ID%type default 0;
50     t_Stack_ID
      RPAccess.Stack_ID%type default 0;

```

55

```

V_Project_ID
    RPAccess.Project_ID$type;
5
V_Module_ID
    RPAccess.Module_ID$type;
V_Originating_Module_ID
10
RPAccess.Originating_Module_ID$type;
V_Object_ID
    RPAccess.Object_ID$type;
15
V_Method_ID
    RPAccess.Method_ID$type;
V_Block_ID
    RPAccess.Block_ID$type default 0;
20
V_Block_sequence_Number
    RPAccess.Block_Sequence_number$type default 0;
V_Access_Name
25
    RPAccess.Access_Name$type;
V_Database_ID
    RPAccess.Database_ID$type;
30
V_Relation_ID
    RPAccess.Relation_ID$type;
V_Access_ID
    RPAccess.Access_ID$type;
35
V_Method_Type_Code
    RPAccess.Method_Type_Code$type;
V_Alias_Name
40
    RPAccess.Alias_Name$type;
v_Linkage_type_code
    RPAccess.Linkage_type_code$type;
45
v_Physical_Name
    DBRelation.Physical_Name$type;
v_Relation_type_code
    DBRelation.Relation_Type_Code$type;
50
V_Backward_Flag
    RPAccess.Backward_Flag$type;
55

```

```

5      V_Generic_Flag
      RPAccess.Generic_Flag%type;
      V_Optional_Flag
      RPAccess.Optional_Flag%type;
10     V_Order_Type_Code
      RPAccess.Order_Type_Code%type;
      V_Sequential_Flag
      RPAccess.Sequential_Flag%type;
15     V_Unique_Flag
      RPAccess.Unique_Flag%type;
      V_Autocommit_Flag
      RPAccess.Autocommit_Flag%type;
20     V_Autolink_Flag
      RPAccess.Autolink_Flag%type default Null;
      V_Nowarn_Flag
      RPAccess.Nowarn_Flag%type;
25     V_Lock_Type_Code
      RPAccess.Lock_Type_Code%type;
      V_Index_ID
      RPAccess.Index_ID%type;
30     V_Stack_ID
      RPAccess.Stack_ID%type default 0;
      V_Audit_Creation_Date
      RPAccess.Audit_Creation_Date%type;
35     V_Audit_Modified_Date
      RPAccess.Audit_Modified_Date%type;
      V_Audit_Update_Type_Code
      RPAccess.Audit_Update_Type_Code%type;
40     V_Audit_Who
      RPAccess.Audit_Who%type;
      V_Audit_Where
45     RPAccess.Audit_Where%type;

      Zero      Number      := 0;
      Spaces    Varchar(04) := ' ';
50
BEGIN
55

```

```

If p_Project_ID is Null or p_project_id = 0
Then
5      Null;
    else
      v_Project_id := p_project_id;
10     End If;

    if p_Module_ID is null or p_Module_ID = 0
    Then
15      Null;
    else
      v_Module_ID := p_Module_ID;
20     End If;

    if p_Originating_Module_ID is null or
p_Originating_Module_ID = 0
25     Then
      Null;
    else
      v_Originating_Module_ID :=
30     p_Originating_Module_ID;
      End If;

35     if p_Object_ID is null or p_Object_ID = 0
    Then
      Null;
    else
40     v_Object_ID := p_Object_ID;
      End If;

45     if p_method_ID is null or p_method_ID = 0
    Then
      Null;
    else
50     v_method_ID := p_method_ID;
      End If;

55
```

```

5      if p_database_ID is null or p_database_ID = 0
      Then
          Null;
      else
          v_database_ID := p_database_ID;
10     End If;

      if p_relation_ID is null or p_relation_ID = 0
15     Then
          Null;
      else
          v_relation_ID := p_relation_ID;
20     End If;

      if p_access_ID is null or p_access_ID = 0
25     Then
          Null;
      else
          v_access_ID := p_access_ID;
30     End If;

      if p_Block_ID is null or p_Block_ID = 0
35     Then
          Null;
      else
          v_block_ID := p_Block_ID;
40     End If;

      if p_Block_sequence_Number is null or
45     p_Block_sequence_Number = 0
      Then
          Null;
      else
          v_block_sequence_number :=
50     p_Block_sequence_number;
55
```

```

      End If;

5      if p_Project_name is Null or p_Project_name = spaces
      Then
        Null;
10      Else
        rp_validate_Project(p_Project_name,
        p_Debug_Switch,t_Project_id);
        V_Project_ID := t_Project_ID ;
15        If P_Debug_Switch = 'Y'
        Then
          DBMS_OUTPUT.PUT_LINE('RPACCESS - Project
20 Validation = ' || t_Project_id);
          End If;
        End If;

      IF p_Module_Name is Null or p_module_name = spaces
      Then
        Null;
30      else
        rp_validate_Module(t_project_id, p_Module_name,
        p_Debug_Switch, t_Module_id);
        V_Module_ID := t_Module_ID ;
35        If P_Debug_Switch = 'Y'
        Then
          DBMS_OUTPUT.PUT_LINE('RPACCESS - Module
40 Validation = ' || t_Module_id);
          End if;
        End IF;

      IF p_Originating_Module_Name is Null and p_module_name
45 <> spaces
      Then
        rp_validate_Module(t_project_id, p_Module_name,
50 p_Debug_Switch, t_Originating_Module_id);

55

```

```

      V_Originating_Module_ID := t_Originating_Module_ID
5      ;

      If P_Debug_Switch = 'Y'
      Then
          DBMS_OUTPUT.PUT_LINE('RPACCESS- Originating
10      Module Validation = ' || t_Originating_module_id);
          End If;
      else
          rp_validate_Module(t_project_id,
15      p_Originating_Module_name, p_Debug_Switch,
          t_Originating_Module_id);
          V_Originating_Module_ID := t_Originating_Module_ID
20      ;

          If P_Debug_Switch = 'Y'
          Then
              DBMS_OUTPUT.PUT_LINE('RPACCESS- Originating
25      Module Validation = ' || t_Originating_module_id);
              End If;
          END If;

30      If p_object_name is null or p_object_name = spaces
      Then
          null;
35      else
          rp_validate_Object(t_project_id, t_Module_id,
          t_Originating_Module_id, p_object_name, P_Object_type_code,
40      p_Debug_Switch, t_Object_id);
          V_Object_ID := t_Object_ID ;
          If P_Debug_Switch = 'Y'
          Then
45      DBMS_OUTPUT.PUT_LINE('RPAccess - Object
          Validation = ' || t_object_id);
          End if;
50      End If;

```

55


```

      If p_Method_Type_code is null or p_method_type_code =
spaces
5       Then
          null;
        else
10         rp_validate_Method(t_project_id, t_Module_id,
          t_Originating_Module_id, t_object_Id, P_Method_type_code,
          p_Debug_Switch , p_Block_Name,
          p_Block_sequence_number,t_Method_id);
15         V_Method_ID           := t_Method_ID ;
          If P_Debug_Switch = 'Y'
          Then
20         DBMS_OUTPUT.PUT_LINE('RPACCESS - Method
Validation = ' || t_method_id);
          End if;
          End If;
25

      If p_Block_name is null
      Then
30         v_Block_id := 0;
      Else
          rp_validate_Code_Block(t_project_id, t_Module_id,
35         t_Originating_Module_id, p_Block_name, p_Debug_Switch,
          t_Block_id, t_Procedure_id);
          V_Block_ID           := t_Block_ID ;
          If P_Debug_Switch = 'Y'
40         Then
          DBMS_OUTPUT.PUT_LINE('RPAccess - Validate Code
Block = ' || t_Block_id);
45         End If;
          End If;
25

      If p_Database_name is null or p_database_name = spaces
50       Then
          null;
55

```

```

else
    DB_validate_Database(p_database_name,
5    p_Debug_Switch,t_database_id);
    V_Database_ID := t_database_ID ;
    If P_Debug_Switch = 'Y'
10    Then
        DBMS_OUTPUT.PUT_LINE('RPAccess - Database = ' ||
t_database_id);
        End If;
15    End IF;

    If p_Relation_name is null or p_Relation_name = spaces
20    Then
        null;
    else
        DB_validate_Relation(t_Database_id,p_Relation_name,
25    p_Debug_Switch,t_Module_id,t_Relation_id);
        v_relation_id := t_relation_id;
        If P_Debug_Switch = 'Y'
30    Then
            DBMS_OUTPUT.PUT_LINE('RPAccess - DBRelation
Validation = ' || t_relation_id);
            End If;
35    If V_Relation_id = 0
        then
            RP_validate_Relation(t_Project_id, t_Module_id,
40    t_originating_module_id, p_relation_name,
p_Debug_Switch,t_Relation_id);
            v_relation_id := t_relation_id;
            If P_Debug_Switch = 'Y'
45    Then
                DBMS_OUTPUT.PUT_LINE('RPAccess - RPRelation
Validation = ' || t_relation_id);
                End If;
50    End If;
        End If;
55

```

```

5      If P_Stack_name is Null or p_Stack_Name = ' '
      Then
          Null;
      else
          rp_validate_Stack(t_project_id, t_Module_id,
10      t_Originating_Module_id, P_Stack_Name, p_Debug_Switch,
          t_Stack_id);
          v_Stack_id      := t_Stack_id;
15      If P_Debug_Switch = 'Y'
          Then
              DBMS_OUTPUT.PUT_LINE('RPAccess - Get Stack = '
|| t_Stack_id);
20      End If;
      End If;

      If P_Index_name is Null or p_Index_Name = ' '
25      Then
          Null;
      else
          rp_validate_Relation_Index(t_project_id,
30      t_Module_id, t_Originating_Module_id, P_Index_Name,
          p_Debug_Switch, t_Index_id);
          v_Index_id      := t_Index_id;
35      If P_Debug_Switch = 'Y'
          Then
              DBMS_OUTPUT.PUT_LINE('RPAccess - Get Index = '
40      || t_Index_id);
          End If;
      End If;

45      V_access_Name := p_access_Name;

      SELECT      Project_ID,
50      Module_ID,
          Originating_Module_ID,
55

```

5 Object_ID,
 Method_ID,
 Access_ID,
 Block_ID,
 Block_Sequence_Number,
 10 Access_Name,
 Database_ID,
 Relation_ID,
 Alias_Name,
 15 Index_ID,
 Stack_ID,
 linkage_Type_Code,
 20 Backward_Flag,
 Generic_Flag,
 Optional_Flag,
 Order_Type_Code,
 25 Sequential_Flag,
 Unique_Flag,
 Autocommit_Flag,
 30 Autolink_Flag,
 Nowarn_Flag,
 Lock_Type_Code,
 Audit_Creation_Date,
 35 Audit_Modified_Date,
 Audit_Update_Type_Code,
 Audit_Who,
 Audit_Where
 40 v_Project_ID,
 v_Module_ID,
 v_Originating_Module_ID,
 45 v_Object_ID,
 v_Method_ID,
 v_Access_ID,
 50 v_Block_ID,
 v_Block_Sequence_Number,
 v_Access_Name,

INTO

```

v_Database_ID,
v_Relation_ID,
5 v_Alias_Name,
v_Index_ID,
v_Stack_ID,
10 v_Linkage_Type_Code,
v_Backward_Flag,
v_Generic_Flag,
v_Optional_Flag,
15 v_Order_Type_Code,
v_Sequential_Flag,
v_Unique_Flag,
20 v_Autocommit_Flag,
v_Autolink_Flag,
v_Nowarn_Flag,
v_Lock_Type_Code,
25 v_Audit_Creation_Date,
v_Audit_Modified_Date,
v_Audit_Update_Type_Code,
v_Audit_Who,
30 v_Audit_Where
FROM RPAccess
WHERE Project_ID = t_Project_ID and
35 Module_ID = t_Module_ID and
Originating_Module_ID =
t_Originating_Module_ID and
40 Object_ID = t_Object_ID and
Method_ID = t_Method_ID and
Block_id = v_Block_id and
Block_Sequence_number =
45 p_Block_sequence_Number and
access_name = p_Access_Name;

50 IF P_Alias_Name is null
Then
55

```

```

        null;
    Else
5      v_Alias_Name := p_Alias_Name;
      End If;

10     IF P_Linkage_Type_code is null
      Then
        null;
      Else
15      v_Linkage_Type_Code := p_Linkage_Type_Code;
      End If;

20     IF P_Backward_Flag is null
      Then
        null;
      Else
25      v_Backward_Flag := p_Backward_Flag;
      End If;
      IF P_Generic_Flag is null
      Then
30      null;
      Else
        v_Generic_Flag := p_Generic_Flag;
35      End If;
      IF P_Optional_Flag is null
      Then
        null;
40      Else
        v_Optional_Flag := p_Optional_Flag;
      End If;
45      IF P_Order_Type_Code is null
      Then
        null;
      Else
50      v_Order_Type_Code := p_Order_Type_Code;
      End If;

```

55

```

5      IF P_Sequential_Flag is null
      Then
          null;
      Else
          v_Sequential_Flag := p_Sequential_Flag;
10     End If;
      IF P_Unique_Flag is null
      Then
15         null;
      Else
          v_Unique_Flag := p_Unique_Flag;
          End If;
20     IF P_Autocommit_Flag is null
      Then
          null;
      Else
25         v_Autocommit_Flag := p_Autocommit_Flag;
          End If;
          IF P_Autolink_Flag is null
30      Then
          null;
      Else
          v_Autolink_Flag := p_Autolink_Flag;
35      End If;
          IF P_Nowarn_Flag is null
      Then
40         null;
      Else
          v_Nowarn_Flag := p_Nowarn_Flag;
          End If;
45     IF P_Lock_Type_Code is null
      Then
          null;
50     Else
          v_Lock_Type_Code := p_Lock_Type_Code;
          End If;
55
```

```

5      IF P_Index_ID is null
      Then
          null;
      Else
          v_Index_ID := p_Index_ID;
10     End If;

      IF P_Stack_ID is null
15     Then
          null;
      Else
          v_stack_ID := p_stack_ID;
20     End If;

      IF P_Audit_Creation_Date is null
25     Then
          null;
      Else
          v_Audit_Creation_Date := p_Audit_Creation_Date;
30     End If;
      IF P_Audit_Modified_Date is null
      Then
35         null;
      Else
          v_Audit_Modified_Date := p_Audit_Modified_Date;
40         End If;
      IF P_Audit_Update_Type_Code is null
      Then
45         null;
      Else
          v_Audit_Update_Type_Code :=
50         p_Audit_Update_Type_Code;
          End If;
      IF P_Audit_Who is null
      Then
55

```



```

        null;
    Else
5       v_Audit_Who := p_Audit_Who;
    End If;
    IF P_Audit_Where is null
10    Then
        null;
    Else
        v_Audit_Where := p_Audit_Where;
15    End If;

UPDATE          RPACCESS
20    SET
        Access_Name = v_Access_Name,
        Database_ID = v_Database_ID ,
        Relation_ID = v_Relation_ID ,
25    Alias_Name = v_Alias_Name ,
        Index_ID = v_Index_ID,
        Stack_ID = v_Stack_ID,
30    Linkage_type_code = v_Linkage_Type_Code,
        Backward_Flag = v_Backward_Flag ,
        Generic_Flag = v_Generic_Flag ,
        Optional_Flag = v_Optional_Flag ,
35    Order_Type_Code = v_Order_Type_Code ,
        Sequential_Flag = v_Sequential_Flag ,
        Unique_Flag = v_Unique_Flag ,
40    Autocommit_Flag = v_Autocommit_Flag ,
        Autolink_Flag = v_Autolink_Flag ,
        Nowarn_Flag = v_Nowarn_Flag ,
        Lock_Type_Code = v_Lock_Type_Code ,
45    Audit_Creation_Date = v_Audit_Creation_Date ,
        Audit_Modified_Date = v_Audit_Modified_Date ,
        Audit_Update_Type_Code = v_Audit_Update_Type_Code .
50
        Audit_Who = v_Audit_Who ,
55

```

```

    Audit_where = v_Audit_where
5   WHERE
      Access_ID           = v_Access_ID and
      Object_ID           = v_Object_ID and
      Method_ID           = v_Method_ID and
10  Project_ID            = v_Project_ID and
      Originating_Module_ID = v_Originating_Module_ID and
      Module_ID           = v_Module_ID and
      Block_id            = v_Block_id and
15  Block_Sequence_number = p_Block_sequence_Number ;

EXCEPTION
20 WHEN NO_DATA_FOUND THEN
    If v_Object_id = 0 or
      v_Object_id is null
25 Then
    IU_RPObject
    (
      p_Project_name,
      p_Module_Name,
30  p_Originating_Module_name,
      p_Object_Name,
      p_object_Type_code,
35  p_debug_switch
    );
    rp_validate_Object(t_project_id, t_Module_id,
40  t_Originating_Module_id, p_object_name, P_Object_type_code,
    p_Debug_Switch,t_Object_id);
    V_Object_ID           := t_Object_ID ;
    If P_Debug_Switch = 'Y'
45  Then
        DBMS_OUTPUT.PUT_LINE('RPAccess - Insert Phase Object
Validation = ' || v_object_id);
50  End If;
    End If;

```

55

```

    If v_Method_id = 0 or
      v_Method_id is null
5      Then
        IU_RPMethod
        (
10          p_Project_name,
          p_Module_Name,
          p_originating_Module_name,
          p_Object_Name,
15          p_object_Type_code,
          p_Method_Type_code,
          p_debug_switch,
          p_Block_Name,
20          p_Block_sequence_number
        );
        rp_validate_Method(t_project_id, t_Module_id,
25        t_Originating_Module_id, t_object_Id, P_Method_type_code,
        p_Debug_Switch, p_Block_Name,
        p_Block_sequence_Number,t_Method_id);
        V_Method_ID      := t_Method_ID ;
30        If P_Debug_Switch = 'Y'
        Then
            DBMS_OUTPUT.PUT_LINE('RPACCESS - Insert Phase Method
35 Validation = ' || v_method_id);
            End If;
            End If;

40    If v_Database_id = 0 or v_Database_id is null
    Then
        IU_DBDatabase
        (
45          p_Database_name,
          p_debug_switch
        );
        DB_validate_Database(p_database_name,
50        p_Debug_switch,t_database_id);

```

55

```

      V_Database_ID                := t_database_ID ;
      If P_Debug_Switch = 'Y'
      Then
          DBMS_OUTPUT.PUT_LINE('RPACCESS - Database = ' ||
t_database_id);
      End If;
      End If;

      If P_Relation_name <> ' '
      then
          IU_RPRelation
          (
              p_Project_name,
              p_Module_Name,
              p_originating_Module_name,
              p_Object_Name,
              p_object_type_code,
              p_method_type_code,
              p_Database_Name,
              p_Relation_Name,
              p_Alias_name,
              p_debug_switch,
              P_Physical_name,
              P_Relation_Type_Code
          );
          DB_validate_Relation(t_Database_id, p_relation_name,
p_Debug_Switch,t_Module_id,t_Relation_id);
          v_relation_id                := t_relation_id;
          If P_Debug_Switch = 'Y'
          Then
              DBMS_OUTPUT.PUT_LINE('RPAccess - RPRelation
Validation = ' || t_relation_id);
          End If;
      End If;

      IF P_Alias_name is null

```

```
Then
  v_Alias_Name := Spaces;
5 Else
  v_Alias_Name := p_Alias_name;
End If;

10 IF P_Linkage_Type_Code is null
  Then
    v_Linkage_Type_Code := Spaces;
15 Else
    v_Linkage_Type_Code := p_Linkage_Type_Code;
  End If;

20 IF P_Backward_Flag is null
  Then
    v_Backward_Flag := Spaces;
25 Else
    v_Backward_Flag := p_Backward_Flag;
  End If;

30 IF P_Generic_Flag is null
  Then
    v_Generic_Flag := Spaces;
35 Else
    v_Generic_Flag := p_Generic_Flag;
  End If;

40 IF P_Optional_Flag is null
  Then
    v_Optional_Flag := Spaces;
45 Else
    v_Optional_Flag := p_Optional_Flag;
  End If;

50 IF P_Order_Type_Code is null
  Then
```

55

```

    v_Order_Type_Code := Spaces;
5   Else
    v_Order_Type_Code := p_Order_Type_Code;
    End If;

10  IF P_Sequential_Flag is null
    Then
    v_Sequential_Flag := Spaces;
    Else
15  v_Sequential_Flag := p_Sequential_Flag;
    End If;

20  IF P_Unique_Flag is null
    Then
    v_Unique_Flag := Spaces;
    Else
25  v_Unique_Flag := p_Unique_Flag;
    End If;

30  IF P_Autocommit_Flag is null
    Then
    v_Autocommit_Flag := Spaces;
    Else
35  v_Autocommit_Flag := p_Autocommit_Flag;
    End If;

40  IF P_Autolink_Flag is null
    Then
    v_Autolink_Flag := Spaces;
    Else
45  v_Autolink_Flag := p_Autolink_Flag;
    End If;

50  IF P_Nowarn_Flag is null
    Then
    v_Nowarn_Flag := Spaces;
55
```

```

Else
    v_Nowarn_Flag := p_Nowarn_Flag;
5   End If;

    IF P_Lock_Type_Code is null
10  Then
        v_Lock_Type_Code := Spaces;
    Else
        v_Lock_Type_Code := p_Lock_Type_Code;
15  End If;

    IF P_Index_ID is null
20  Then
        v_Index_ID := Zero;
    Else
        v_Index_ID := p_Index_ID;
25  End If;

    IF P_Stack_ID is null
30  Then
        v_Stack_ID := Zero;
    Else
        v_Stack_ID := p_Stack_ID;
35  End If;

    IF P_Audit_Creation_Date is null
40  Then
        v_Audit_Creation_Date := Sysdate;
    Else
        v_Audit_Creation_Date := p_Audit_Creation_Date;
45  End If;

    IF P_Audit_Modified_Date is null
50  Then
        v_Audit_Modified_Date := Sysdate;
    Else
55

```

```

5      v_Audit_Modified_Date := p_Audit_Modified_Date;
      End If;

      IF P_Audit_Update_Type_Code is null
      Then
10         v_Audit_Update_Type_Code := Spaces;
      Else
         v_Audit_Update_Type_Code :=
15         p_Audit_Update_Type_Code;
      End If;

      IF P_Audit_Who is null
      Then
20         v_Audit_Who := Spaces;
      Else
         v_Audit_Who := p_Audit_Who;
25         End If;

      IF P_Audit_Where is null
      Then
30         v_Audit_Where := Spaces;
      Else
         v_Audit_Where := p_Audit_Where;
35         End If;

      INSERT INTO RPAccess
40         VALUES (v_Project_ID,
                   v_Module_ID,
                   v_Originating_Module_ID,
45                   v_Object_ID,
                   v_Method_ID,
                   RPAccess_IDS.NEXTVAL,
                   v_block_id,
50                   v_block_sequence_number,
                   v_Access_Name,
55

```



```

v_Database_ID,
v_Relation_ID,
5 v_Alias_Name,
v_Index_ID,
v_stack_ID,
10 v_Linkage_Type_Code,
v_Backward_Flag,
v_Generic_Flag,
15 v_Optional_Flag,
v_Order_Type_Code,
v_Sequential_Flag,
20 v_Unique_Flag,
v_Autocommit_Flag,
v_Autolink_Flag,
25 v_Nowarn_Flag,
v_Lock_Type_Code,
v_Audit_Creation_Date,
v_Audit_Modified_Date,
30 v_Audit_Update_Type_Code,
v_Audit_Who,
v_Audit_Where);

35 WHEN OTHERS THEN
    /* Handler which executes for all other errors. */
    v_ErrorCode := SQLCODE;
    v_ErrorText := SUBSTR(SQLERRM, 1, 200);
40 INSERT INTO log_table (code, message, api, info) VALUES
    (v_ErrorCode, v_ErrorText, 'RPAccess', 'Oracle error
    occurred');
45 END IU_RPAccess;
/

50

```

H. Data Model structures for the Dynamic Tree view Navigators

[0060] Figure 4 shows a representation of structures represented in the Data Model which form the cornerstone on which the user interface behavior is controlled and managed. For each required node on the tree view, a node and the associated information required to determine the data to be displayed and defined and stored in the structures represented in this figure.

I. Visual Basic Dynamic Tree View Navigator

[0061] Figure 5 is a screenshot of a tree view. The code required to create this tree view dynamically (data driven) is illustrated in the figure.

5 [0062] The following code dynamically creates the tree view for the preferred embodiment. This code determines what information is to be displayed in the tree view. It references the "CreateNode" procedure (in order to create each node in the tree view) which is demonstrated in the description is following this procedure.

```

10  Public Sub LoadNode(ByVal strKey As String, ByVal
    strParentRelation As String)

15      '-----
      '-----
      '
20      ' This procedure loads the node and adds 2 images into the
      imagelist to be displayed
      ' in the treeview.
      '
25      ' This procedure accepts the following parameters:
      '
      strKey - The key of the parent node. (Ie.
30      ">NODE>3>Project_Id>1")

35

40

45

50

55

```

```

5      strParentRelation - The relation from which the parent
information was retrieved.
      ' (Ie. The parent relation is
RPPProject when clicking a Module)
      '-----
10      -----

      Dim strSQL As String
      Dim intCol As Integer
15      Dim lngId As Long
      Dim imgImage As ListImage
      Dim strRefElement As String
20      Dim strRefElements() As typElementInfo
      Dim intElementCount As Integer
      Dim strSortElement As String
      Dim strSortElements As String
25      Dim rsResults As rdoResultset
Resultset for the reference table info.
      Dim rsNodes As rdoResultset
30      Resultset for the node table info.
      Dim strRPNodeKey As String
the primary key info.
      ' Stores
      Dim strOpenPicture As String
35      the location of the open icon.
      ' Stores
      Dim strClosedPicture As String
the location of the closed icon.
      ' Stores
40      Dim strReferenceRelation As String
the reference relation.
      ' Stores
      Dim lngParentID As Long
the parent node id.
      ' Stores
45      Dim strName As String
the name to display for the node.
      ' Stores
      Dim lngParentNodeID As Long
50      the node's parent id.
      ' Stores
      Dim lngNodeId As Long
the node's id.
      ' Stores
55

```

```

5      Dim strSourceRelation As String           ' Stores
the relation to fetch the source info.

      Dim strPrimaryKey As String               ' Stores
the elements that make up the PK.

10     Dim strRelations As String               ' Stores
the concatenated source and reference relations.

      Dim lngLastNodeId As Long                 ' Stores
the previous node viewed.

15     Dim blnNodeIdChanged As Boolean           ' Stores
if the node has changed.

      Dim strWhereClause As String              ' Stores
the WHERE clause.

20     Dim strWhereClauseFields As String        ' Fields
that make up the where clause.

      Dim intPos As Integer

25     Dim intArrayCount As Integer
      Dim blnAddToArray As Integer
      Dim strPK As String
      Dim strSeparator As String
30     Dim blnDistinct As Boolean
      Dim strNodeName As String
      Dim strProcDir As String ' Delete
      Dim strProcFile As String
35     Dim strProcedure As String
      Dim strSortType As String
      Dim strOperators As String

40     On Error GoTo ADErr

      ' If this is a root node, clear the treeview.
45     If Len(strKey) = 0 Then
        tvwTables.Nodes.Clear
        lngParentNodeID = ROOT_NODE
      Else
50     lngParentNodeID = GetValue(">NODE>", strKey)
      End If

55

```

```

' Check if a connection to the database exists.
5   If gobjDBConnect.rdoDB Is Nothing Then Exit Sub

Screen.MousePointer = vbHourglass

10  ' Reset this value to false.
    pblnCheckedNodeCount = False

15  ' Select the Node information from the RPNodes table.
    strSQL = "SELECT Reference_Relation, Reference_Element,"
    strSQL = strSQL & " Node_Id, Open_Picture, Closed_Picture,
20  Sort_Element,"
    strSQL = strSQL & " Node_Relation, Node_Element,
    Node_Display_Description,"
    strSQL = strSQL & " Parent_Relation, Parent_Element,
25  Value, Separator, Static_Flag,"
    strSQL = strSQL & " Element_Name, Source_Relation,
    Documentation_Flag,"
    strSQL = strSQL & " Display_Flag, Distinct_Flag,
30  Relation_Separator, Operator,"
    strSQL = strSQL & " Node_List_Relation, Node_List_XRef,
    Node_Name,"
35  strSQL = strSQL & " External_Directory, External_File,
    Procedure_To_Call"
    strSQL = strSQL & " FROM RPNode_Select_Reference_View"
    strSQL = strSQL & " WHERE Parent_Node_Id = " &
40  lngParentNodeID
    strSQL = strSQL & " AND Tree_Group_Code = " &
    StrToFld(pstrTreeType)
45  strSQL = strSQL & " ORDER BY Sequence_Number,
    Distinct_Flag, Sort_Sequence, Node_Sequence"

    Set rsNodes = gobjDBConnect.rdoDB.OpenResultset(strSQL,
50  rdOpenForwardOnly, rdConcurReadOnly, rdExecDirect)
    strRPNodeKey = ""

```

55

```

Do While Not rsNodes.EOF
5 Continuation_Point: ' If the node changed (meaning
display static data), return here.

' Set this value to an empty string so that we don't
10 pass the incorrect
' primary key. Reset the NodeId to FALSE.
strPrimaryKey = ""
15 strRPNodeKey = ""
strWhereClauseFields = ""
strSortElements = ""
Erase strRefElements()
20 blnNodeIdChanged = False

' Store the values.
25 lngNodeId = rsNodes("Node_Id").Value
strOpenPicture = rsNodes("Open_Picture").Value & ""
strClosedPicture = rsNodes("Closed_Picture").Value & ""
30 strNodeName = rsNodes("Node_Name").Value & ""

' If the Static_Flag = '0001', then we are displaying
SELECT, VARIABLES, LITERALS, etc.
35 If rsNodes("Static_Flag").Value & "" = YES_STR Then

If lngLastNodeId <> rsNodes("Node_Id") Then
40 lngLastNodeId = rsNodes("Node_Id") & ""

strReferenceRelation =
45 rsNodes("Node_Display_Description").Value & ""
' If we haven't checked the node count, do it now.
If pblnCheckedNodeCount = False Then
If Len(Trim$(rsNodes("Node_List_Relation") & ""))
50 Then

```

55

```

        Call CheckNodeCount(strKey,
rsNodes("Node_List_Relation") & "",
5 rsNodes("Node_List_XRef") & "")
        End If
        End If

10
        ' Used for editable static nodes, such as Original
        Sources.
        ' This allows us to edit the source table which
15 contains the BLOB.
        strSourceRelation = rsNodes("Source_Relation").Value
        & ""

20
        ' Check if this node is to be displayed.
        If DisplayNode(rsNodes("Node_List_XRef").Value & "")
        Then
25
            On Error Resume Next
            ' Load the imagelist with the new items.
            Set imgImage = imlTreePics.ListImages.Add(,
            Set imgImage = imlTreePics.ListImages.Add(,
30 strNodeName & "_Closed", LoadPicture(strClosedPicture))
            Set imgImage = imlTreePics.ListImages.Add(,
            strNodeName & "_Open", LoadPicture(strOpenPicture))
            strRelations = strSourceRelation & ";" &
35 strReferenceRelation
            ' Create the node.
            strWhereClauseFields = strWhereClauseFields & "<"
            & strOperators
40
            Call CreateNode(strKey, lngNodeId, strRelations,
            rsNodes("Node_Display_Description").Value, strPrimaryKey,
            strWhereClauseFields, strNodeName)
45
            End If
            End If

        Else
50
            ' Store the relevant information for the nodes.

```

```

strReferenceRelation =
5 rsNodes("Reference_Relation").Value & ""
strSourceRelation = rsNodes("Source_Relation").Value &
""

10 lngLastNodeId = lngNodeId
strWhereClauseFields = ""
' Fetch all of the element_names that make up the
primary key.
15 ' Exit the loop if a new Node_Id is found..
Do While Not rsNodes.EOF
If lngLastNodeId <> rsNodes("Node_Id").Value Then
20 ' Node Id has changed.
blnNodeIdChanged = True
Exit Do
Else
25 ' Keep looping to fetch the necessary values.
lngLastNodeId = rsNodes("Node_Id").Value
strRefElement = rsNodes("Reference_Element").Value
30 & ""
strSortElement = rsNodes("Sort_Element").Value &
""

35 ' Check if the array or the string is empty.
On Error Resume Next
If UBound(strRefElements) < 0 And
Len(Trim$(strRefElement)) > 0 Then
40 If Err.Number = 9 Then ' Subscript out of
range.
Err.Clear
45 End If
ReDim Preserve strRefElements(0) As
typeElementInfo
strRefElements(0).strElement = strRefElement
50 strRefElements(0).strSeparator =
rsNodes("Separator").Value & ""
55

```



```

    strRefElements(0).strDistinctFlag =
5   rsNodes("Distinct_Flag").Value & ""
    strRefElements(0).strDisplayFlag =
    rsNodes("Display_Flag").Value & ""
    strRefElements(0).strExternalDir =
10   Trim$(rsNodes("External_Directory") & "")
    strRefElements(0).strExternalFile =
    Trim$(rsNodes("External_File") & "")
    strRefElements(0).strProcedure =
15   Trim$(rsNodes("Procedure_To_Call") & "")
    intElementCount = intElementCount + 1
    End If
20   If Len(strSortType) = 0 Then strSortType = "ASC"
    If Len(strSortElements) = 0 And
    Len(Trim$(strSortElement)) > 0 Then strSortElements =
25   strSortElement & "-" & strSortType & ";"

    ' Check if we want to add the element to the
    array.

30   blnAddToArray = True
    For intArrayCount = 0 To UBound(strRefElements)
    If strRefElements(intArrayCount).strElement =
    strRefElement Then
35       blnAddToArray = False
    Exit For
    End If
40   Next

    ' Add the element to the array.
    If blnAddToArray Then
    ReDim Preserve strRefElements(intElementCount)
45   As typElementInfo
    strRefElements(intElementCount).strElement =
    strRefElement
50   strRefElements(intElementCount).strSeperator =
    rsNodes("Seperator").Value & ""

```

55

```

        strRefElements(intElementCount).strDistinctFlag
5   = rsNodes("Distinct_Flag").Value & ""
        strRefElements(intElementCount).strDisplayFlag =
        rsNodes("Display_Flag").Value & ""
        strRefElements(intElementCount).strExternalDir =
10   Trim$(rsNodes("External_Directory") & "")
        strRefElements(intElementCount).strExternalFile
        = Trim$(rsNodes("External_File") & "")
        strRefElements(intElementCount).strProcedure =
15   Trim$(rsNodes("Procedure_To_Call") & "")
        intElementCount = intElementCount + 1
        End If

20
        If AddItemToString(strSortElements,
        strSortElement, ";") Then
            strSortType = rsNodes("Sort_Type_Code")
            If Len(strSortType) = 0 Then strSortType = "ASC"
            strSortElements = strSortElements &
25   strSortElement & "-" & strSortType & ";"
        End If

30
        ' Element_Name returns the elements that are part
        of the primary key.
35   If Trim$(rsNodes("Element_Name") & "") <> "" Then
        ' Check whether to add the item to the string.
        If AddItemToString(strRPNodeKey,
        rsNodes("Element_Name").Value, ";") Then
40   strRPNodeKey = rsNodes("Element_Name").Value &
        ";" & strRPNodeKey
        End If

45
        ' Check if fields have been added to the
        WhereClauseFields variable.
        If Len(strWhereClauseFields) Then
50   ' If there are fields, this ensures that no
        duplicates are added.

```

55

```

      If InStr(1, strWhereClauseFields,
rsNodes("Node_Relation") & rsNodes("Relation_Separator") &
5 rsNodes("Node_Element") & rsNodes("Operator")) = 0 Then
      strWhereClauseFields = strWhereClauseFields
      & (rsNodes("Node_Relation") & "") &
10 (rsNodes("Relation_Separator").Value & "") &
      (rsNodes("Node_Element") & "") & (rsNodes("Operator").Value
      & "")
      strOperators = strOperators &
15 rsNodes("Operator") & ","
      If (rsNodes("Parent_Relation") & "") = " "
      Then
          ' Check if the type is a string value.
          ' If rsNodes("Value").Type > 7 Or
          rsNodes("Value").Type < 2 Then
              ' strWhereClauseFields =
25 strWhereClauseFields & StrToFld((rsNodes("Value") & "")) &
              ";"
              'Else
              strWhereClauseFields =
30 strWhereClauseFields & (rsNodes("Value") & "") & ";"
              'End If
          Else
              strWhereClauseFields =
35 strWhereClauseFields & (rsNodes("Parent_Relation") & "") &
              (rsNodes("Relation_Separator").Value & "") &
              (rsNodes("Parent_Element") & "") & ";"
40 End If
          End If
      Else
          ' Add the first field to the WhereClauseFields
45 that is part of the where clause.
          If Len(rsNodes("Node_Relation") & "") Then
              strWhereClauseFields = strWhereClauseFields
50 & (rsNodes("Node_Relation") & "") &
              (rsNodes("Relation_Separator").Value & "") &

```

55

```

5      (rsNodes("Node_Element") & "") & (rsNodes("Operator").Value
      & "")
      strOperators = strOperators &
      rsNodes("Operator") & ","
10     If (rsNodes("Parent_Relation") & "") = " "
      Then
          'If rsNodes("Value").Type > 7 Or
          rsNodes("Value").Type < 2 Then
15         ' strWhereClauseFields =
          strWhereClauseFields & StrToFld((rsNodes("Value") & "")) &
          ","
20         'Else
          strWhereClauseFields =
          strWhereClauseFields & (rsNodes("Value") & "") & ","
25         'End If
          Else
          strWhereClauseFields =
          strWhereClauseFields & (rsNodes("Parent_Relation") & "") &
30         (rsNodes("Relation_Separator").Value & "") &
          (rsNodes("Parent_Element") & "") & ","
          End If
          End If
35       End If
          End If
          End If
          rsNodes.MoveNext
40       End If
          Loop
          On Error Resume Next
          ' Load the imagelist with the new items.
          Set imgImage = imlTreePics.ListImages.Add(,
          strNodeName & "_Closed", LoadPicture(strClosedPicture))
50       Set imgImage = imlTreePics.ListImages.Add(,
          strNodeName & "_Open", LoadPicture(strOpenPicture))
55

```

```

      ' Return the primary key values into this string. We
5      will remove any duplicate fields.
      strPK = ReturnPrimaryKey(strRPNodeKey)

      ' Select the detailed information from the Source
10     Relation.
      strSQL = "SELECT "
      For intArrayCount = 0 To UBound(strRefElements)
          If UBound(strRefElements) > 0 And strSQL <> "SELECT
15     " Then strSQL = strSQL & ", "
          If strRefElements(intArrayCount).strDistinctFlag =
YES_STR Then
20         blnDistinct = True
          strSQL = strSQL & "DISTINCT(" &
strRefElements(intArrayCount).strElement & ")"
          Else
25         strSQL = strSQL &
Trim$(strRefElements(intArrayCount).strElement)
          End If
30         ' Remove duplicates from the primary key.
          strPK = RemoveDuplicates(strPK,
strRefElements(intArrayCount).strElement)
      Next
35     If Not blnDistinct Then
        If Len(strPK) Then
            If strSQL = "SELECT " Then
40                strSQL = strSQL & strPK
            Else
                If Right$(strSQL, 2) = ", " Then strSQL =
Left$(strSQL, Len(strSQL) - 2)
45                strSQL = strSQL & ", " & strPK
            End If
        End If
50     End If
      strSQL = strSQL & " FROM " & strReferenceRelation

```

55

```

      ' Add the WHERE clause of the SQL statement.
5      ' If no node was clicked (form loaded), then do the
      first part of the IF statement.
      If Len(strKey) = 0 Then
10         If pstrTreeType = PROJECT_TREE Then
            strSQL = strSQL & " WHERE " & Left$(strRPNodeKey,
            Len(strRPNodeKey) - 1) & " = " & plngProjectID
            End If
15         Else
            ' Ensure that there is a where clause.
            strWhereClause = ReturnWhereClause(strKey,
            strWhereClauseFields, strParentRelation, strOperators)
20         If Trim$(strWhereClause) <> "" Then
            strSQL = strSQL & " WHERE " & strWhereClause
            End If
25         End If

        ' Add the sort criteria.
        strSQL = strSQL & " ORDER BY " &
30        ReturnSortElements(strSortElements)

        Set rsResults =
35        gobjDBConnect.rdoDB.OpenResultset(strSQL, rdOpenForwardOnly,
        rdConcurReadOnly, rdExecDirect)

        If rsResults.EOF Then
40            If strReferenceRelation = "RPPProject" Then
                MsgBox "There are no Projects in the system."
                Screen.MousePointer = vbArrow
45                Exit Sub
            End If
50            strRelations = strSourceRelation & ";" &
            strReferenceRelation
55

```

```

      ' Reset the array
      On Error GoTo ADErr
5      Do While Not rsResults.EOF

          strPrimaryKey = ""
10          ' Create the primary key.
          For intCol = 0 To rsResults.rdoColumns.Count - 1
              ' Build the primary key from the resultset
              ensuring all applicable fields are used.
15              intPos = InStr(1, strRPNodeKey,
rsResults(intCol).Name, vbTextCompare)
              If intPos > 0 Then
                  If intPos = 1 Then
20                      strPrimaryKey = strPrimaryKey & ">" &
rsResults(intCol).Name & ">" & rsResults(intCol).Value
                  Else
25                      If Mid$(strRPNodeKey, intPos - 1, 1) = ";"
Then
                          strPrimaryKey = strPrimaryKey & ">" &
rsResults(intCol).Name & ">" & rsResults(intCol).Value
30                      Else
                          intPos = InStr(intPos + 1, strRPNodeKey,
rsResults(intCol).Name, vbTextCompare)
35                      If intPos > 0 Then
                          strPrimaryKey = strPrimaryKey & ">" &
rsResults(intCol).Name & ">" & rsResults(intCol).Value
                          End If
40                      End If
                  End If
                  End If
45              Next

          strName = ""
          For intArrayCount = 0 To UBound(strRefElements)
50              If strRefElements(intArrayCount).strDisplayFlag <>
NO_STR Then

```

55

```

      If
5      Trim$(strRefElements(intArrayCount).strElement) <> "" Then
          If Len(strName) And
              Len(Trim$(rsResults(strRefElements(intArrayCount).strElement
10              ).Value & "")) > 0 Then strName = strName & strSeparator
              strName = strName &
              Trim$(rsResults(strRefElements(intArrayCount).strElement).Va
              lue & "")

          ' If the separator is a period with no leading
15          or trailing spaces, then
          ' don't add the trailing and leading space
          that we do with the other separators.
          If strRefElements(intArrayCount).strSeparator
20          = "." Then
              strSeparator = "."
          Else
25              strSeparator = " " &
              Trim$(strRefElements(intArrayCount).strSeparator) & " "
          End If
          Else
30              ' Check if we call the expression editor.
              If strRefElements(intArrayCount).strProcedure
              <> "" And strName = "" Then
35                  strName =
                  GetExpression(strRefElements(intArrayCount).strProcedure,
                  strRefElements(intArrayCount).strExternalDir,
                  strRefElements(intArrayCount).strExternalFile,
40                  strPrimaryKey, strReferenceRelation)
              End If
              End If
45          End If
          Next

          ' Create the node.
50          strWhereClauseFields = strWhereClauseFields & "<" &
          strOperators

```

55


```

      Call CreateNode(strKey, lngNodeId, strRelations,
5      strName, strPrimaryKey, strWhereClauseFields, strNodeName)
      rsResults.MoveNext
      Loop

10      End If

      If blnNodeIdChanged Then GoTo Continuation_Point

15      On Error Resume Next
      rsNodes.MoveNext

20      Loop

      rsNodes.Close
25      On Error Resume Next
      rsResults.Close

30      Screen.MousePointer = vbDefault

      Exit Sub

35      ADerr:
      Dim errError As rdoError, strMsg As String
      For Each errError In rdoEngine.rdoErrors
40          strMsg = strMsg & errError.Number & " - " &
errError.Description & vbCr
      Next
45      Screen.MousePointer = vbArrow
      MsgBox strMsg, vbOKOnly + vbExclamation, App.ProductName

50      End Sub

```

55 [0063] The following code is preferably used to create the node (Physically) in the treeview.

```

Private Sub CreateNode(ByVal strKey As String, ByVal
5 lngNodeId As Long, ByVal strRelations As String, ByVal
strName As String, ByVal strPrimaryKey As String,
strWhereClauseFields As String, strNodeName As String)

10 ' This procedure creates the physical node on the treeview
form.

15 Dim nodX As Node ' Create variable.
Dim strCurNodeKey As String
Dim intPos As Integer
Dim strReferenceRelation As String

20 strCurNodeKey = ">NODE>" & lngNodeId

intPos = InStr(1, strRelations, ";")
25 strReferenceRelation = Mid$(strRelations, intPos + 1,
Len(strRelations) - intPos)

30 ' If strRPNodeKey is blank, then don't include the next
statement.
If Trim$(strPrimaryKey) <> "" Then
35 If Right$(strCurNodeKey, 1) = ">" Then strCurNodeKey =
Left$(strCurNodeKey, Len(strCurNodeKey) - 1)
strCurNodeKey = strCurNodeKey & strPrimaryKey
Else
40 intPos = InStr(1, strKey, ">NODE>", vbTextCompare)
intPos = InStr(intPos + Len(">NODE>"), strKey, ">")
On Error Resume Next
45 strCurNodeKey = strCurNodeKey & Mid$(strKey, intPos,
(Len(strKey) - intPos) + 1)
End If
strCurNodeKey = tvwTables.Nodes.Count & strCurNodeKey

50 ' If strKey is blank, then the node is a root node.

```

```

On Error Resume Next
If Len(strKey) <> 0 Then
5   Set nodX = tvwTables.Nodes.Add(strKey, tvwChild,
    strCurNodeKey, strName, strNodeName & "_Closed")
Else
10  Set nodX = tvwTables.Nodes.Add(, , strCurNodeKey, strName,
    strNodeName & "_Closed")
End If
15
nodX.Tag = strRelations & ">" & strWhereClauseFields

20 End Sub

```

25 *J. Visual Basic Dynamic Property Sheet*

[0064] The following code dynamically creates a Property Sheet for the preferred embodiment of the invention.

30

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```
Private Sub LoadData(ByVal strWhereClause As String)
```

```

5      ' -----
      ' -----
      '
10     ' This procedure loads the data in the grid. If lngValue is
      ' passed,
      ' then the data is loaded because the user selected an item
      ' from the
15     ' cboObjects combo box.
      '
      ' The grid contains the following information:
20     ' Field 0 - Field Name (ie. Project_ID)
      ' Field 1 - Value (ie. oms for Project_ID = 1 if that is the
      ' associated Project_Name)
25     ' Field 2 - Control type to be used. (ie. Display value in
      ' a combo box, text box, elipsis)
      ' Field 3 - Value (same as Field 1, but used to compare if
30     ' the fields were changed.)

```

```

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```

' Field 4 - Size of field (ie. 10 for Varchar2(10))
' Field 5 - Data type (ie. Varchar2, Numeric, Timestamp,
5 etc.)
' Field 6 - Modifiable (ie. Allow modifications to this
field?)
' Field 7 - Primary Key? (ie. Is this field part of the
10 primary key?
' Field 8 - Actual value from main table.
' Field 9 - Source view or table (ie.
15 RPCross_Reference_DeCode_View)
'
' -----
20 -----

Dim cl As rdoColumns
rdoColumns collection
25 Dim intCurrent As Integer
indexes
Dim strSQL As String
30 string.
Dim rsCrossReference As rdoResultset
Resultset for RPCross_Reference_View
Dim strFieldName As String
35 Dim typArray() As ptypCrossReference
Dim intCount As Integer
Dim intCurPosition As Integer
Dim strValue As String
40 Dim blnArrayEmpty As Boolean
Dim blnAlternateValueFound As Boolean
Dim intAlternatePosition As Integer
45 Dim blnDisplayValue As Boolean
Dim strWhere As String
Dim strSource As String
Dim strElementName As String
50 Dim intLessNumRows As Integer
' If the
column is not to be displayed,

55

```

```

subtract this number from the current row

5
On Error GoTo LoadData_ER
pblnDisplayControl = False
Call ClearGrid
10
grdData.ColAlignment(1) = 0 ' Left align.
If Len(strWhereClause) Then
    strSQL = Me.SQLCriteria(strWhereClause)
15
Else
    strSQL = Me.SQLCriteria("")
End If

20
' Create the resultset for the table.
Set rsResult = gobjDBConnect.rdoDB.OpenResultset(strSQL,
rdOpenForwardOnly, rdConcurReadOnly, rdExecDirect)
25
Set cl = rsResult.rdoColumns

' Fetch the values from the lookup table.
30
strSQL = "SELECT * FROM RPCross_Reference_view"
strSQL = strSQL & " WHERE UPPER(Relation_Name) = " &
UCase(StrToFld(Left$(Me.SourceTable, InStr(1,
Me.SourceTable, ";") - 1)))
35

Set rsCrossReference =
gobjDBConnect.rdoDB.OpenResultset(strSQL, rdOpenForwardOnly,
40
rdConcurReadOnly, rdExecDirect)

blnArrayEmpty = True
Do While Not rsCrossReference.EOF
45
    blnArrayEmpty = False
    intCount = intCount + 1
    ReDim Preserve typArray(intCount)
    typArray(intCount).Control_Type_Code =
50
    rsCrossReference("Control_Type_Code").Value & ""

```

55

```

    typArray(intCount).Display_Flag =
5   rsCrossReference("Display_Flag").Value & ""
    typArray(intCount).Element_Name =
    rsCrossReference("Element_Name").Value & ""
    typArray(intCount).Full_English_Desc =
10  rsCrossReference("Full_English_Desc").Value & ""
    typArray(intCount).Reference_Group =
    rsCrossReference("Reference_Group").Value & ""
    typArray(intCount).Modifiable_Flag =
15  rsCrossReference("Modifiable_Flag").Value & ""
    typArray(intCount).Reference_Code =
    rsCrossReference("Reference_Code").Value & ""
    typArray(intCount).Primary_Key_Flag =
20  rsCrossReference("Primary_Key_Flag").Value & ""
    typArray(intCount).Reference_Database =
    rsCrossReference("Reference_Database").Value & ""
    typArray(intCount).Reference_Relation =
25  rsCrossReference("Reference_Relation").Value & ""
    typArray(intCount).Reference_Element =
    rsCrossReference("Reference_Element").Value & ""
    typArray(intCount).Reference_Display_Element =
30  rsCrossReference("Reference_Display_Element").Value & ""
    typArray(intCount).NodeID =
    rsCrossReference("Node_Id").Value & ""
    typArray(intCount).ParentNodeID =
    rsCrossReference("Parent_Node_Id").Value & ""
    typArray(intCount).TreeGroupCode =
40  rsCrossReference("Tree_Group_Code").Value & ""
    rsCrossReference.MoveNext
    Loop
45  rsCrossReference.Close
    Set rsCrossReference = Nothing

    ' Insert the data into the grid
50  For intCurrent = 0 To rsResult.rdcColumns.Count - 1

```

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```

      If intCurrent > pintRowsVisible - 1 Then          ' Add a
5      new row for each column in the
          grdData.Rows = intCurrent + 1 - intLessNumRows
      ' rdcColumns collection.
          grdData.RowHeight(intCurrent - intLessNumRows) = 280
10      End If

      On Error Resume Next
          grdData.Row = intCurrent - intLessNumRows
15      If Err.Number = 30009 Then      ' Invalid row value.
          grdData.Rows = intCurrent + 1 - intLessNumRows
      ' rdcColumns collection.
          grdData.RowHeight(intCurrent - intLessNumRows) = 280
20      grdData.Row = intCurrent - intLessNumRows
          Err.Clear
          On Error GoTo 0
25      End If

      ' Store the field name and value to be used later.
30      strFieldName = cl(intCurrent).Name
          On Error Resume Next
          strValue = cl(intCurrent).Value
          On Error GoTo 0
35

      grdData.Col = 2

      ' For the current field, loop through the array and see if
40      the field has any related
      ' values in the cross reference table. This allows us to
      later display the value
45      ' rather than the code.
          strSource = 0
          intCurPosition = 0
          intAlternatePosition = 0
50      If Not blnArrayEmpty Then
          For intCount = 1 To UBound(typArray)
55

```



```

      If Trim$(UCase(typArray(intCount).Element_Name)) =
5      UCase(strFieldName) Then
          If typArray(intCount).Reference_Code = strValue Then
              strSource = RPCROSS_REFERENCE_VIEW
              blnDisplayValue = True
10              intCurPosition = intCount
              Exit For
          Else
15              strSource = RPCROSS_REFERENCE_VIEW ' CV
              End If
              ' If there is a value for the Reference Relation and
              Element, then retrieve this value
20              ' (description) from the database. This is used when
              displaying ID's from the database.
              If Len(Trim$(typArray(intCount).Reference_Relation))
25              > 0 And Len(Trim$(typArray(intCount).Reference_Element)) > 0
              Then
                  ' If we are getting a blob, then do the following.
                  If typArray(intCount).Control_Type_Code =
30                  CONTROL_BLOB Then
                      strSQL = "{CALL RPBlob_Extract(P_Blob_Id=>" &
                      strValue & ", P_FileName=>" & strValue & ".txt')}"
35                      Dim intVal As Integer
                      intVal = gobjDBConnect.COREExecute(strSQL)
                      If intVal <> False Then
                          ' Read the textfile.
40                          Open GetSetting("Chameleon", "Options",
                          "Temporary Directory", RetrieveTempDir) & "\" & strValue &
                          ".txt" For Binary As #1
45                          strValue = Input(LOF(1), #1)
                          Close #1
                          End If
                      Else
50                          ' Retrieve the PK values for the table from
                          which we are fetching the description.
55

```

```

      strSQL = "SELECT * FROM
5  RPCross_Reference_Decode_View WHERE"
      strSQL = strSQL & " Node_Id = " &
      typArray(intCount).NodeID
      strSQL = strSQL & " AND Tree_Group_Code =
10  '0099'"

      Set rsCrossReference =
      gobjDBConnect.rdoDB.OpenResultset(strSQL, rdOpenForwardOnly,
15  rdConcurReadOnly, rdExecDirect)

      ' Select the value from the source table.
      strSQL = "SELECT " &
20  typArray(intCount).Reference_Display_Element
      strSQL = strSQL & " FROM " &
      typArray(intCount).Reference_Relation
      strSQL = strSQL & " WHERE "
25  strWhere = ""
      Do While Not rsCrossReference.EOF
      ' Create the WHERE clause.
      strElementName = ""
30  strElementName =
      rsCrossReference("Node_Element")
      If InStr(1, strWhere, " " &
35  (rsCrossReference("Parent_Element")) & " = " &
      rsResult(strElementName)) = 0 Then
      If Len(strWhere) Then strWhere = strWhere &
40  " AND "
      strWhere = strWhere &
      (rsCrossReference("Parent_Element")) & " = " &
45  rsResult(strElementName)
      End If
      rsCrossReference.MoveNext
      Loop
50  If Len(strWhere) Then
      strSQL = strSQL & strWhere
      Else
55

```

```

        strSQL = Left$(strSQL, Len(strSQL) - 7)
    End If

    Set rsCrossReference =
    gobjDBConnect.rdoDB.OpenResultset(strSQL, rdOpenForwardOnly,
10   rdConcurReadOnly, rdExecDirect)
        ' Check if a resultset was populated.
    If Not rsCrossReference.EOF Then
        strValue = rsCrossReference(0).Value & ""
15   End If

        ' Concatenate the NODE_ID to strSource for later
20   use.
        strSource = RPCROSS_REFERENCE_DECODE_VIEW & "-"
        & typArray(intCount).NodeID

25         intAlternatePosition = intCount
        blnAlternateValueFound = True
    End If
30   End If
    If typArray(intCount).Display_Flag = NO_STR Then
        intAlternatePosition = intCount
        blnAlternateValueFound = True
35   End If
    If typArray(intCount).Modifiable_Flag = NO_STR Then
        intAlternatePosition = intCount
        blnAlternateValueFound = True
40   End If
    If typArray(intCount).Primary_Key_Flag = YES_STR
    Then
45         intAlternatePosition = intCount
        blnAlternateValueFound = True
    End If
    If typArray(intCount).Control_Type_Code <>
50   CONTROL_TEXT Then
        intAlternatePosition = intCount
55

```

```

        blnAlternateValueFound = True
    End If
End If
Next
End If

    If intCurPosition = 0 And blnAlternateValueFound = True
Then
    intCurPosition = intAlternatePosition
End If

    ' If no match was found, enter the value from the
SourceTable, otherwise, use the value
    ' from the cross reference table.
    If intCurPosition = 0 Then
        grdData.Text = CONTROL_TEXT
        grdData.Col = 0
        grdData.Text = strFieldName
        grdData.Col = 1
        If cl(intCurrent).Type = rdTypeTIMESTAMP Then
            grdData.Text = Format(cl(intCurrent).Value & "",
GetSetting("Chameleon", "Options", "DateFormat",
"DD/MM/YYYY"))
            grdData.Col = 3
            grdData.Text = Format(cl(intCurrent).Value & "",
GetSetting("Chameleon", "Options", "DateFormat",
"DD/MM/YYYY"))
        Else
            grdData.Text = cl(intCurrent).Value & ""
            grdData.Col = 3
            Enter the value in the fourth column as well so that
            grdData.Text = cl(intCurrent).Value & ""
            can verify if the value has changed.
        End If
        grdData.Col = 4
        Store the size of the data in this column, so as to

```

```

5       If cl(intCurrent).Type = rdTypeTIMESTAMP Then
           grdData.Text = 19
       Else
           grdData.Text = cl(intCurrent).Size & ""
           limit what can be entered into the textbox.
10      End If
           grdData.Col = 5
           grdData.Text = cl(intCurrent).Type & ""
15      grdData.Col = 6
           grdData.Text = YES_STR
           grdData.Col = 8
           grdData.Text = cl(intCurrent).Value & ""
20      grdData.Col = 9
           grdData.Text = strSource
       Else
25      If typArray(intCurPosition).Display_Flag = YES_STR Then
           grdData.Text =
typArray(intCurPosition).Control_Type_Code
           grdData.Col = 0
30      grdData.Text = strFieldName
           grdData.Col = 1
           If blnAlternateValueFound = False Or blnDisplayValue
35      Then
           ' If we are to display a description from the
full_english_desc field.
           blnDisplayValue = False
40      grdData.Text =
typArray(intCurPosition).Full_English_Desc
           grdData.Col = 3
45      grdData.Text =
typArray(intCurPosition).Full_English_Desc
           Else
           blnAlternateValueFound = False
50      If cl(intCurrent).Type = rdTypeTIMESTAMP Then

```

55

```

      grdData.Text = Format(strValue,
5   GetSetting("Chameleon", "Options", "DateFormat",
      "DD/MM/YYYY"))
      grdData.Col = 3
      grdData.Text = Format(strValue,
10  GetSetting("PROGNAME", "Options", "DateFormat",
      "DD/MM/YYYY"))
      Else
      grdData.Text = strValue
15  grdData.Col = 3
      grdData.Text = strValue
      End If
20  End If
      grdData.Col = 4
      Store the size of the data in this column, so as to
      If cl(intCurrent).Type = rdTypeTIMESTAMP Then
25  limit what can be entered into the textbox.
      grdData.Text = 19
      Else
30  If typArray(intCurPosition).Control_Type_Code =
      CONTROL_BLOB Then
      grdData.Text = 0
      Else
35  grdData.Text = cl(intCurrent).Size & ""
      End If
      End If
      grdData.Col = 5
40  grdData.Text = cl(intCurrent).Type & ""
      grdData.Col = 6
      grdData.Text =
45  typArray(intCurPosition).Modifiable_Flag
      grdData.Col = 7
      grdData.Text =
      typArray(intCurPosition).Primary_Key_Flag
50  grdData.Col = 8
      On Error Resume Next

```

55

```

        grdData.Text = cl(intCurrent).Value & ""
    On Error GoTo 0
    grdData.Col = 9
    grdData.Text = strSource
Else
    intLessNumRows = intLessNumRows + 1
End If
End If
Next
grdData.Col = 0
If grdData.Text = "" Then
    grdData.Rows = grdData.Rows - 1
End If

' Reset the column
grdData.Col = 0
grdData.Row = 0

' Set the column width.
grdData.ColWidth(1) = (grdData.Width * 0.6) - 80

cboCombo.Visible = False
txtText.Visible = False
cmdElipsis.Visible = False

Exit Sub

LoadData_ER:
    MsgBox Err.Number & " - " & Err.Description, vbOKOnly +
        vbExclamation, App.ProductName

End Sub

```

55 *K. Code Segment for Forward Engineering Component*

[0065] The following code manages dynamically generates PL/SQL source code based on the objects that have been design recovered and stored in the CORE Chameleon repository. This specific excerpt is designed to create the equiv-

alent SQL "SELECT" statement component if the newly generated Oracle PL/SQL report.

```

5      CREATE OR REPLACE PROCEDURE RPKG_GET_SELECT (
          p_project_id
          RPEvent_Detail.Project_ID%Type ,
          p_module_id
10      RPEvent_Detail.Module_ID%Type,
          p_Debug_Switch                      Varchar2
          Default null ,
          p_FileDir                          VARCHAR2 Default
15      'c:\core\Temp',
          p_FileName                          VARCHAR2 default
          'Report.sql') AS
20
          v_Database_Name                    DBDatabase.Database_Name%Type;
          v_Relation_Name                    DBRelation.Relation_Name%Type;
25      v_Element_Name                        DBElement.Element_Name%Type;
          v_Alias_Name                       RPRelation.Alias_Name%Type;
          v_Related_Database_Name
30      DBDatabase.Database_Name%Type;
          v_Related_Relation_Name            DBRelation.Relation_Name%Type;
          v_Related_Element_Name             DBElement.Element_Name%Type;
          v_Variable_Name
35      RPVariable.Variable_Name%Type;
          v_stack_id                         RPStack.Stack_ID%Type;
          v_FileHandle                       UTL_FILE.FILE_TYPE;
40      v_Called_Module                      Varchar2(1) default 'Y';
          t_Counter                          Integer default 0;

```



```

T_expression                                varchar2(2000);

5
Cursor C_RPRELATION_FIELD Is
    SELECT Relation_Name, Alias_Name, Element_Name
    FROM   RPRELATION_FIELD_VIEW
10      WHERE Project_id      = p_project_id AND
            Module_id        = p_module_id ;

15
Cursor C_RPAccess Is
    SELECT Relation_Name, Alias_Name
    FROM   RPAccess_VIEW
    WHERE  Project_id      = p_project_id AND
20        Module_id        = p_module_id
    ORDER BY Access_ID;

25
Cursor C_RPACCESS_FIELD Is
    SELECT Database_Name, Relation_Name, Element_Name,
            Related_Database_Name, Related_Relation_Name,
    Related_Element_Name, Stack_id
30      FROM   RPACCESS_FIELD_VIEW
    WHERE  Project_id      = p_project_id AND
            Module_id        = p_module_id
35      Order By Access_id;

Cursor C_RPSORT_OPTION Is
    SELECT Relation_Name, Element_Name, Variable_Name
40      FROM   RPSORT_OPTION_VIEW
    WHERE  Project_id      = p_project_id AND
            Module_id        = p_module_id
45      Order By SORT_ORDER;

Begin

50
DBMS_OUTPUT.ENABLE(1000000);

55

```

```

-----
5  -- Get The elements That are to be selected

    v_FileHandle := UTL_FILE.FOPEN(p_FileDir, p_FileName, 'a');
10  Open C_RPRELATION_FIELD;
    t_Expression := 'SELECT ';
    UTL_FILE.PUT_line(v_FileHandle, T_expression );
15  t_expression := ' ';

    <<RPRELATION_FIELD_LOOP>>
    Loop
20  Fetch C_RPRELATION_FIELD Into v_Relation_Name,
    v_Alias_Name, v_Element_Name;

    Exit RPRELATION_FIELD_LOOP When C_RPRELATION_FIELD%NOTFOUND;
25

    If v_Alias_Name != ' '
    Then
30      T_expression := T_expression || ' ' ||
    v_Alias_Name || '.' || v_Element_Name;
    Else
        T_expression := T_expression || ' ' ||
35  v_Relation_Name || '.' || v_Element_Name;
    End If;

40  UTL_FILE.PUT_line(v_FileHandle, t_expression );
    t_expression := ' ';

45  End Loop RPRELATION_FIELD_LOOP;
    Close C_RPRELATION_FIELD;

-----
50  -- Get The Relation That are to be selected from

```

55

```

Open C_RPACCESS;
t_Expression := 'FROM ';
5   UTL_FILE.PUT_line(v_FileHandle, t_expression );
t_expression := ' ';

10  <<RPACCESS_LOOP>>
Loop
Fetch C_RPACCESS Into v_Relation_Name, v_Alias_Name;

15  Exit RPACCESS_LOOP When C_RPACCESS%NOTFOUND;

T_expression := T_expression || ' ' ||
20  V_Relation_Name || ' ' || v_Alias_name;

UTL_FILE.PUT_line(v_FileHandle, t_expression );
t_expression := ' ';

25  End Loop RPACCESS_LOOP;
Close C_RPACCESS;

30  -----
-----

35  -- Get The Items That Make up the Where Clause of the select
statement for the Program

Open C_RPACCESS_FIELD;
t_Counter := 0;
40  <<RPACCESS_FIELD_LOOP>>
Loop
Fetch C_RPACCESS_FIELD Into v_Database_name,
45  V_Relation_name, v_Element_Name,
v_Related_Database_name,
V_Related_Relation_name, v_Related_Element_Name,
50  v_Stack_id;
Exit RPACCESS_FIELD_LOOP When C_RPACCESS_FIELD%NOTFOUND;

```

55

```

t_Counter := t_Counter + 1;

5
If t_Counter = 1
Then
    t_Expression := 'WHERE ';
10    UTL_FILE.PUT_line(v_FileHandle, T_expression );
    t_expression := ' ';
End If;

15
If v_STACK_ID != 0
Then
    T_expression := T_expression || '          ' ||
20    V_Relation_Name || '.' || v_Element_name || ' = ' ;
    RP_Get_Stack_Detail( p_project_id, p_module_id,
    p_Module_id, v_stack_id, 0, p_Debug_Switch, T_expression,
25    v_called_module );
Else
    T_expression := T_expression || '          ' ||
    V_Relation_Name || '.' || v_Element_name || ' = ' ||
30    V_Related_Relation_Name || '.' || v_Related_Element_name ;
End If;

35    UTL_FILE.PUT_line(v_FileHandle, t_expression );
    t_expression := ' ';

End Loop RPACCESS_FIELD_LOOP;
40    Close C_RPACCESS_FIELD;

-----
45    -- Get The Sort Options That are to be used In the Program

Open C_RPSORT_OPTION;
t_Counter := 0;
50    <<RPSORT_OPTION_LOOP>>
Loop

55

```

```

Fetch C_RPSORT_OPTION Into V_Relation_name, v_Element_Name,
5 v_variable_Name;

Exit RPSORT_OPTION_LOOP When C_RPSORT_OPTION%NOTFOUND;

10 t_Counter := t_Counter + 1;

If t_Counter = 1
15 Then
    t_Expression := 'ORDER BY ';
    UTL_FILE.PUT_line(v_FileHandle, T_expression );
    t_expression := ' ';
20 End If;

If V_Variable_Name != ' '
25 Then
    T_expression := T_expression || ' ' ||
    V_Variable_Name;
Else
30 T_expression := T_expression || ' ' ||
    V_Relation_Name || '.' || v_Element_name;
End If;

35 UTL_FILE.PUT_line(v_FileHandle, t_expression );
t_expression := ' ';

40 End Loop RPSORT_OPTION_LOOP;
Close C_RPSORT_OPTION;

-----
45 -----
UTL_FILE.FCLOSE(v_FileHandle);

Return;

50 EXCEPTION

55

```

```

-- Handle the UTL_FILE exceptions meaningfully, and make
5  sure
-- that the file is properly closed.
  WHEN UTL_FILE.INVALID_PATH THEN
    UTL_FILE.FCLOSE(v_FileHandle);
10    RAISE_APPLICATION_ERROR(-20060,
                                'RPGen_Get_Select: Invalid
Path');
15    WHEN UTL_FILE.INVALID_MODE THEN
      UTL_FILE.FCLOSE(v_FileHandle);
      RAISE_APPLICATION_ERROR(-20061,
                                'RPGen_Get_Select: Invalid
Mode');
20    WHEN UTL_FILE.INVALID_FILEHANDLE THEN
      UTL_FILE.FCLOSE(v_FileHandle);
25    RAISE_APPLICATION_ERROR(-20062,
                                'RPGen_Get_Select: Invalid File
Handle');
    WHEN UTL_FILE.INVALID_OPERATION THEN
30      UTL_FILE.FCLOSE(v_FileHandle);
      RAISE_APPLICATION_ERROR(-20063,
                                'RPGen_Get_Select: Invalid
Operation');
35    WHEN UTL_FILE.READ_ERROR THEN
      UTL_FILE.FCLOSE(v_FileHandle);
40    RAISE_APPLICATION_ERROR(-20064,
                                'RPGen_Get_Select: Read Error');
    WHEN UTL_FILE.WRITE_ERROR THEN
      UTL_FILE.FCLOSE(v_FileHandle);
45    RAISE_APPLICATION_ERROR(-20065,
                                'RPGen_Get_Select: Write
Error');
50    WHEN UTL_FILE.INTERNAL_ERROR THEN
      UTL_FILE.FCLOSE(v_FileHandle);
      RAISE_APPLICATION_ERROR(-20066,
55

```

```

Error');
5 WHEN OTHERS THEN
    UTL_FILE.FCLOSE(V_FileHandle);
    RAISE_APPLICATION_ERROR(-20069,
10 'RPGen_Get_Select: Unknown
Error');

```

```

END RPGEN_GET_SELECT;
15 /

```

L. *Generated PL/SQL Source Code*

20 The following sample PL/SQL program represents the converted report, from its original QUIZ format. All of the program code is automatically generated, without any manual intervention.

```

--
30 ----- PROJECT NAME      :    Sales History
----- PROJECT MANAGER    :
----- PROJECT LEADER     :
----- PROJECT START DATE  :    25-AUG-98
35 ----- PROJECT DESCRIPTION :    0
-----
-----
40 -----
----- MODULE NAME        :    ORDERREP
----- MODULE SOURCE      :    sales.qzs
----- MODULE TYPE        :    quiz
45 ----- MODULE DESCRIPTION :
-----
50 -----
-----

```

55

```

5      ----- Prompts -----

      DECLARE

10     ----- CORE SOFTWARE Variables -----
      v_FileHandle                                UTL_FILE.FILE_TYPE;

      ----- Variables that hold information defined in the
15     original report -----
      D_DISCOUNT_PERCENT                        numeric(2);
      D_DISCOUNT                                numeric(7);

20     ----- Variables that hold information fetched in the cursor
      -----
      T_ORDER_ORDER_AMT
25     ORDER.ORDER_AMT%Type;
      T_ORDER_ORDER_ID
      ORDER.ORDER_ID%Type;

30     CURSOR C_Report_Cursor Is
      Select

35         ORDER.ORDER_AMT,
         ORDER.ORDER_ID

      From

40         ORDER      ;

      -----
      -----

45     BEGIN

      ----- Open a file to store output -----
50     V_FileHandle := UTL_FILE.FOPEN("C:\TEMP", "ORDERREP.TXT");

55

```



```

----- Open Cursor and Fetch, Exit when no more data -----
5 OPEN C_Report_Cursor;
LOOP
Fetch C_Report_Cursor Into
10     T_ORDER_ORDER_AMT,
        T_ORDER_ORDER_ID;

EXIT WHEN C_Report_Cursor%NOTFOUND;

15

----- Definitions of Variables -----
D_DISCOUNT_PERCENT := 7 / 100;

20

If T_ORDER_ORDER_AMT > 10000
then
25     D_DISCOUNT := D_DISCOUNT_PERCENT *
T_ORDER_ORDER_AMT;
else
30     D_DISCOUNT := 0;
End If;

35

----- Conditions to satisfy output criteria -----

----- Write Record to file -----
40     UTL_FILE.PUT_Line( v_FileHandle, T_ORDER_ORDER_ID || ',' ||
T_ORDER_ORDER_AMT || ',' || D_DISCOUNT);

45

END LOOP;

UTL_FILE.FCLOSE(V_FileHandle);

50

END;
/

55

```

-- Code Generation Completed

5

[0066] The above has thus described a method of recovering design information of a legacy application program using a common set of tokens to represent corresponding elements of a plurality of different application programs which are in the same or in different languages, and using a set of the tokens relating to a particular legacy application program to display aspects of the legacy application program or to construct another application program in the same or in a different language which is similar to or is modified from the legacy application program.

[0067] A person understanding this invention may now conceive of alternate embodiments and enhancements using the principles described herein. All such embodiments and enhancements are considered to be within the spirit and scope of this invention as defined in the claims appended hereto.

15

Claims

1. A method of recovering design information of a legacy application program comprising:
 - (a) parsing an application program to obtain plural parsed program parts,
 - (b) storing plural tokens which are common to similarly functioning program parts of various computer languages in a database,
 - (c) mapping the parsed program parts to corresponding ones of the common tokens in the database, and storing the map in the database, and
 - (d) using the mapped tokens to generate a modified legacy application, a new application in a same language as the legacy application, a new application in a language different from the legacy application, or for display of aspects of the legacy or new application via a user interface.
2. A method as defined in claim 1, in which the modified legacy application or either new application contains substantially the same objects, methods and business rules as contained in the legacy application program, devoid of syntax specific aspects thereof.
3. A method as defined in claim 1 including storing a distinct knowledge database for each of plural program languages, and using one of the knowledge databases and a corresponding one of plural parsers to carry out the parsing step in respect of a source code language used in the legacy application.
4. A method as defined in claim 3, in which the step of storing the map includes selecting ones of the common tokens which correspond to parsed program parts and storing copies thereof in a separate database or record related to the legacy application program.
5. A method as defined in claim 3, in which the step of storing the map includes selecting ones of the common tokens which correspond to parsed program parts and storing pointers to the selected ones of the common tokens in a separate database or record related to the legacy application program.
6. A method as defined in claim 1 including searching the mapped tokens for a particular string, and generating a modified legacy application using a modified string in place of the particular string.
7. A method as defined in claim 6 in which the particular string is comprised of a two character year designation, and substituting a four character year designation in place of the two character year designation as the modified string.
8. A method as defined in claim 1 in which the database is a relational database.
9. A method of recovering design information of a legacy application program comprising using a common set of tokens to represent corresponding elements of a plurality of different application programs which are in the same or in different languages, and using a set of the tokens relating to a particular legacy application program to display aspects of the legacy application program or to construct another application program in the same or in a different language which is similar to or is modified from the legacy application program.

55

10. A method of recovering design information of a legacy application program comprising translating the legacy application program into tokens representing elements of the program, and automatically rewriting the legacy application program using the tokens to define elements to be included in the rewritten program.

5 11. A method as defined in claim 10 including rewriting the legacy application program in a computer language which is different from that of the legacy application program.

12. A method as defined in claim 10 including modifying at least one parameter of the legacy application program prior to or as it is being rewritten.

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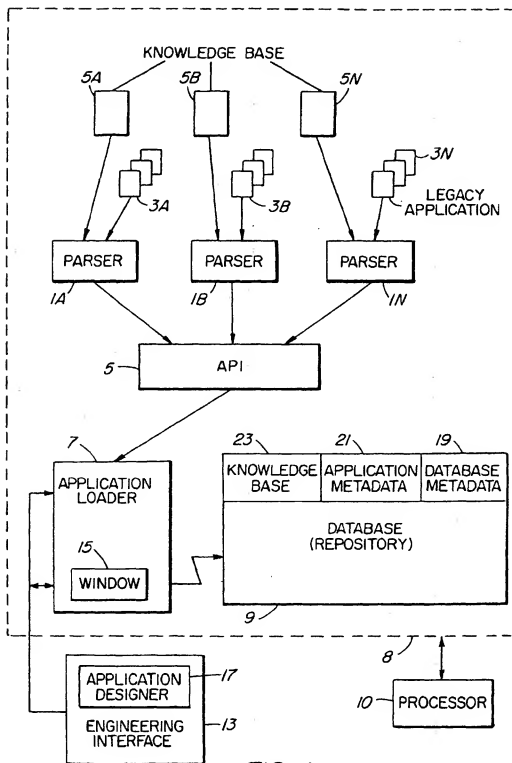


FIG. 1

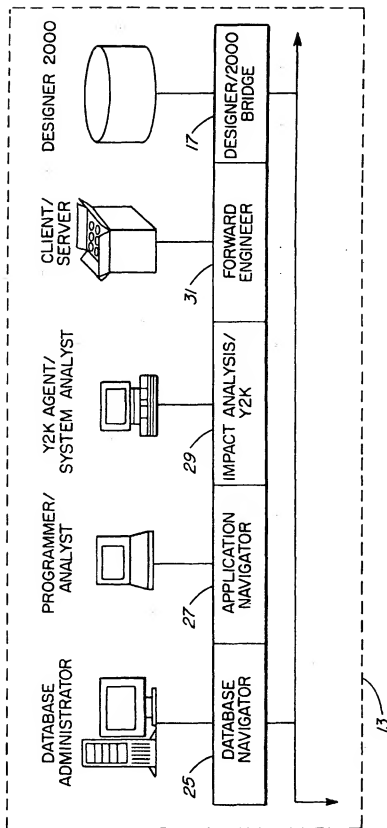


FIG. 2

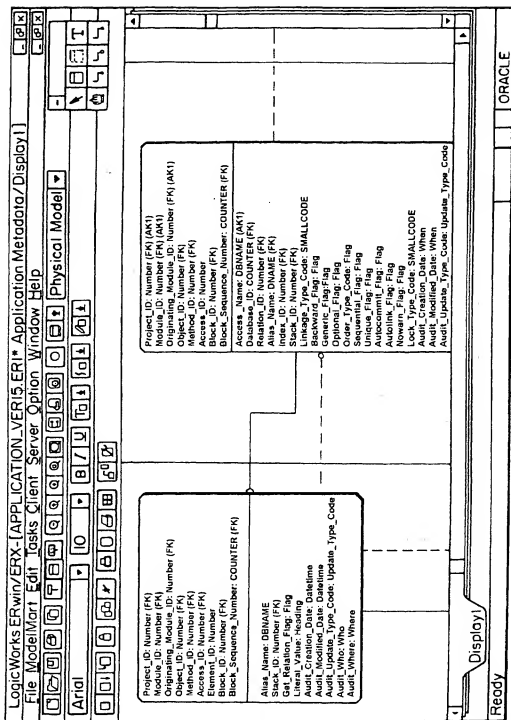
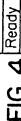


FIG. 3



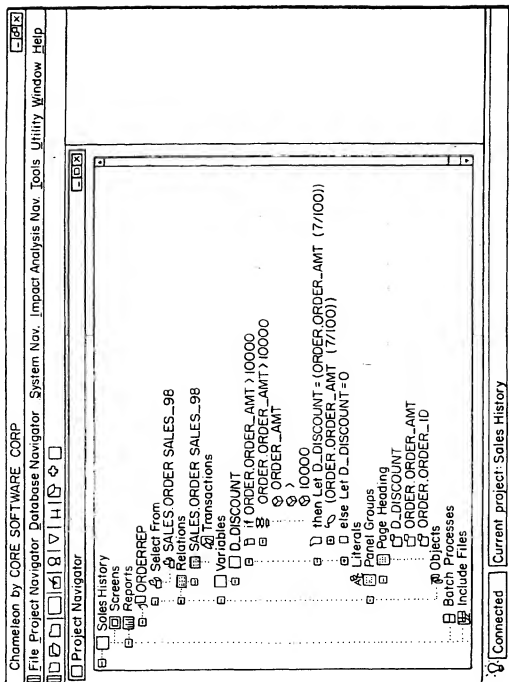


FIG. 5

European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 30 9216

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	PATENT ABSTRACTS OF JAPAN vol. 013, no. 570 (P-977), 18 December 1989 (1989-12-18) & JP 01 237726 A (HITACHI LTD), 22 September 1989 (1989-09-22) * abstract *	1-12	G06F9/44
X	US 5 590 270 A (TSUKUDA GUNJI ET AL) 31 December 1996 (1996-12-31) * column 1, line 30 - column 5, line 12 *	1-12	
X	EP 0 520 708 A (DIGITAL EQUIPMENT CORP) 30 December 1992 (1992-12-30) * page 2, line 13 - page 4, line 48 *	1-12	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			G06F
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 16 December 1999	Examiner Brandt, J
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 98 30 9216

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

16-12-1999

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			JP 5224949 A	03-09-1993

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